Final Report

Rose Canyon Fisheries

Sustainable Aquaculture Project

Report to:

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Table of Contents

List of Tables

List of Figures

1.0 Introduction/Overview

This document contains an analysis of potential environmental impacts associated with the Sustainable Aquaculture Project that is being proposed by Rose Canyon Fisheries, Inc. (RCF). The project, herein referred to as RCF-SAP, would represent the first commercial-scale, offshore fish farm in the federal waters of the United States (U.S.). In addition to being commercially viable, the project is designed to monitor and evaluate concerns related to the environmental sustainability of offshore aquaculture.

RCF is a collaboration between Hubbs-SeaWorld Research Institute (HSWRI) and Cuna del Mar (CdM). HSWRI is a 501(C)(3), non-profit, public trust research foundation dedicated to providing effective solutions to conflicts that arise between human activity and the natural world, while CdM is a private equity fund dedicated to developing sustainable, open-ocean aquaculture. By combining the scientific and environmental expertise of HSWRI with the mission focus and experience in open ocean aquaculture of CdM, RCF will help pioneer environmentally and economically sustainable methods to meet our nation's growing demand for healthy, high quality seafood.

The proposed project would rear yellowtail jack (*Seriola lalandi*) in sea cages that would be located 7.2 kilometers (4.5 miles) from the southern California shoreline, near Mission Bay, San Diego (Latitude 32°44.469'N, Longitude 117°19.931'W) (Figure 1-1). Production will be phased, beginning at 1,000 to 1,500 metric tons (MT) in the first production cycle in order to achieve operational efficiency and ensure environmental compatibility. Based on these data, the project will gradually expand to 5,000 MT in annual production by year eight.

Figure 1-1. Project Location

Yellowtail jack has been chosen as the initial production species; however, the site would also be permitted for other local species such as white seabass (*Atractoscion nobilis*) and striped bass (*Morone saxalis*), which would be interchangeable with yellowtail jack once the project becomes operational, depending on the availability of juveniles and permit conditions. The fish will be reared in state-of-the-art surface and submersible cages, and the farm will have the capacity to to test new containment systems as they are developed.

If successful, this project will serve as a model for the development of additional marine aquaculture projects in the waters offshore the United States. It will create jobs, including new opportunities for commercial fishermen, and it will ensure that the existing infrastructure for fish processing and distribution has a viable future. The consumer will benefit from a year-round supply of high quality, locally produced, fresh seafood that is both safe and healthful. The local production of a supplemental supply of high quality farmed fish will be significantly more efficient than capture fisheries or land-based practices can achieve. In addition, the availability of high quality farmed fish may help to ease pressure on wild fisheries.

The remainder of this document is divided into four major sections.

- ***Proposed Project Description*** – A general description of the proposed RCF-SAP.
- ***Scope and Approach to the Environmental Evaluation*** – The scope and approach to the project-specific and cumulative environmental impact evaluation.
- ***Proposed Project Environmental Evaluation*** – Presents the environmental baseline and environmental impacts of the proposed RCF-SAP, together with proposed mitigation measures. The analysis in this section is presented by issue area.
- ***Coastal Zone Management Act Consistency*** – Presents an evaluation of the project's consistency with the Coastal Zone Management Act and California's approved Coastal Management Program.

The document also contains a number of attachments which serve to support this evaluation.

2.0 Project Description

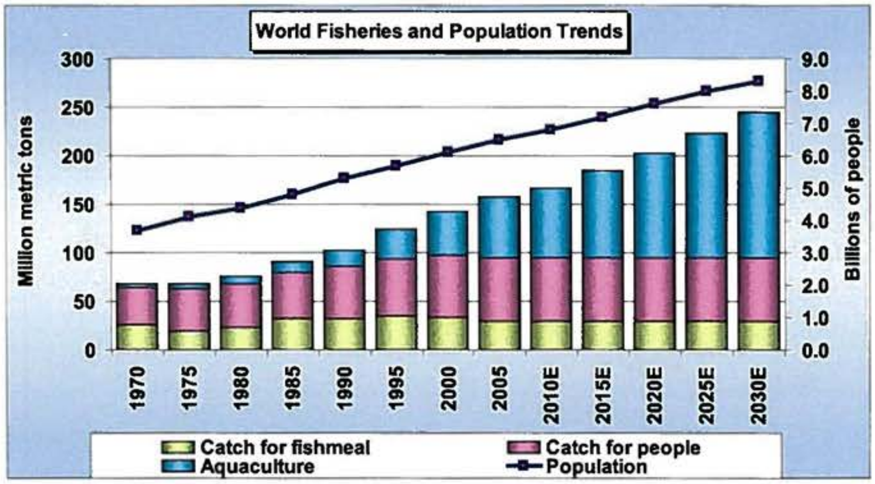
This section provides a description of the proposed RCF-SAP, detailing the need for the project, its scope and supplying details of the project site and project approach.

2.1 Project Need

The RCF-SAP is being driven by a combination of the ever-increasing global demand for seafood and a corresponding dearth of domestic production. Fish are considered a high- protein, low-fat food and contain a wide variety of vitamins and minerals including vitamins A and D, phosphorus, magnesium, and selenium. Fish are also high in omega-3 fatty acids, and are a primary source of these acids in the human diet (NIH 2005). These essential nutrients are critical nutrients necessary for normal brain and eye development of infants, and maintaining good cardiovascular health (Eilander et al 2007, OSU 2010). They may also have beneficial or preventative roles in people with arthritis, irregular heartbeats or depression, and may assist in halting mental decline in the elderly (OSU 2010, Mazereeuw et al 2012).

According to the Food and Agriculture Organization of the United Nations (FAO), approximately 17% of the world's population of 7 billion individuals (Figure 2-1) currently relies on fisheries and aquaculture as their primary source of animal protein (FAO 2014). In some coastal and island countries this number can exceed 70%. This dependence on fish is expected to continue to increase, particularly as the proportion of individuals residing in urban areas increases.

Figure 2-1. Trends in World Fisheries, Aquaculture and Human Population

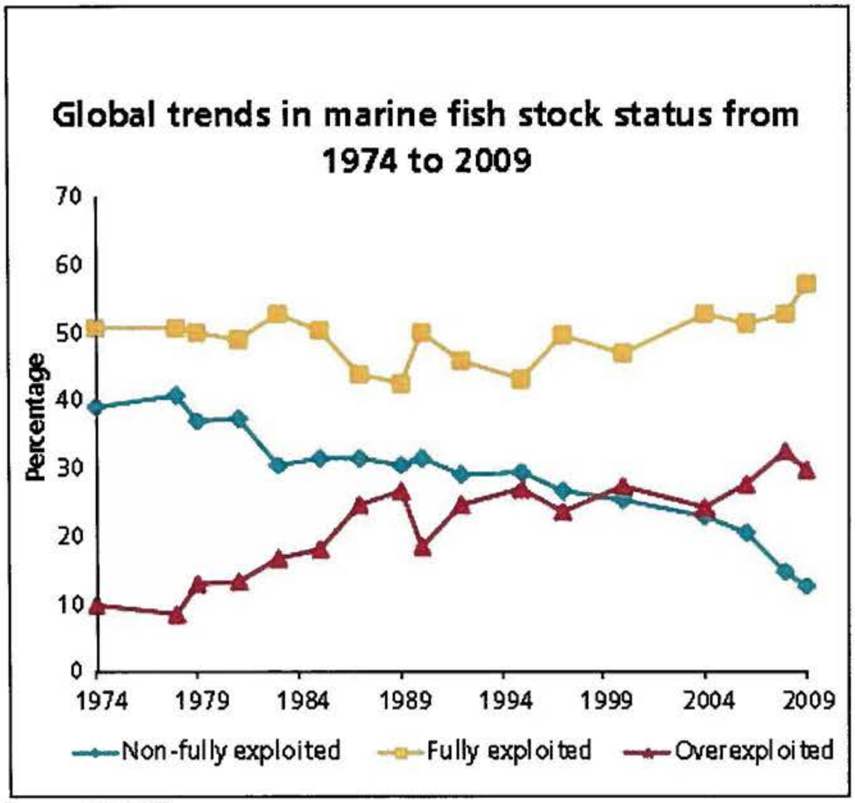


Source: Chu & Anderson, NOAA pers. comm.

The world's population is expected to exceed 8 billion by 2025, and top 9 billion by 2050 (Figure 2-1). At the same time, the planet's urban population – which overtook the number of rural residents in 2010 – is likely to increase to more than 6 billion. The United Nations cautions that sustainable urbanization requires cities to generate better income and employment opportunities, and "expand the necessary infrastructure for water and sanitation, energy, transportation, information and communications; ensure equal access to services; reduce the number of people living in slums; and preserve the natural assets within the city and surrounding areas" (UN 2012).

As a result of population growth and the pressures of increasing urbanization, the FAO projects that up to 40 million metric tons of additional seafood will be required annually by the world's consumers by 2030 (FAO 2014). The majority of traditional fisheries are already at or near their maximum production levels, however, with many fisheries becoming depleted (FAO 2014). According to the FAO, in 1974, 40% of the global fishery resources remained "underexploited or moderately exploited" while 10% were considered "overexploited or depleted". As of 2009, however, 57.4% of global fishery stocks monitored by the FAO were considered "fully exploited (FAO 2011) (Figure 2-2). These stocks produced catches that were already at or very close to their maximum sustainable production. They have no room for further expansion in catch, and there exists some risk of decline if not properly managed. Similarly, 29.9% of the stocks evaluated were considered overexploited, meaning they produced lower yields than their biological and ecological potential. These stocks require strict management plans to rebuild their stock abundance to restore full sustainable productivity. Only 12.7% of the monitored stocks were considered to be non-fully exploited in 2009.

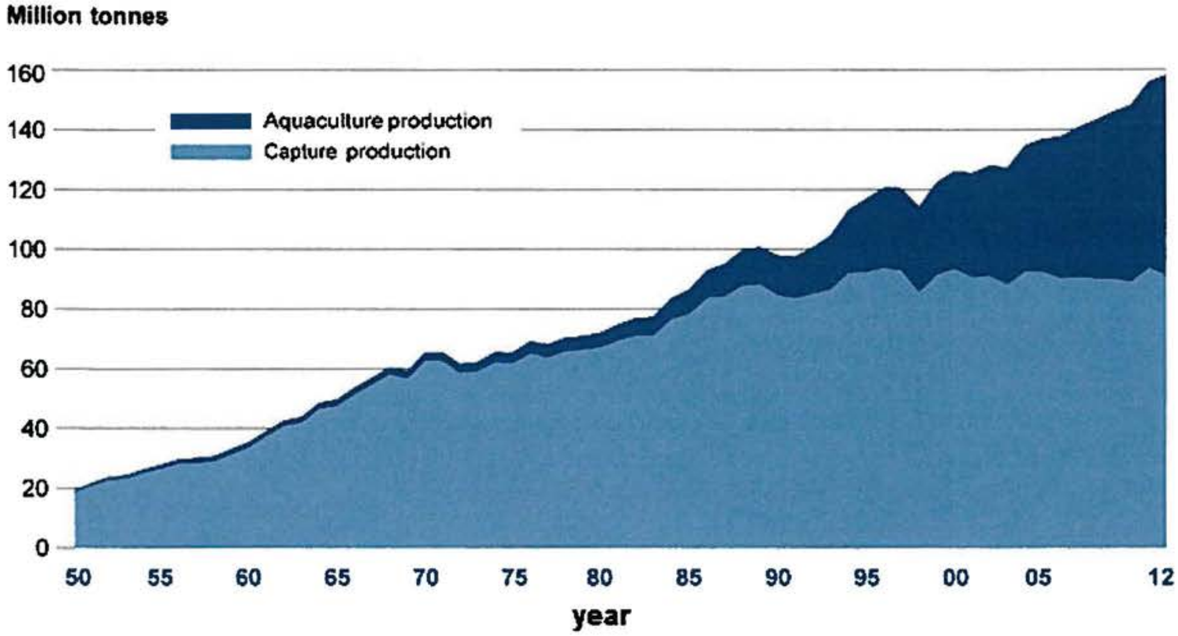
Figure 2-2. Global trends in marine fish stock status



Source: FAO 2011.

Since many capture fisheries are already at or near their maximum sustainable yields, the anticipated future increases in demand can only be met by increased production from aquaculture. Not surprisingly, aquaculture has become one of the fastest-growing food-producing sectors both domestically and worldwide, with global production of food fish more than doubling (from 32.4 million to 66.6 million tonnes) in the period from 2000–2012, an average rate of 6.2 percent annually (FAO 2014) (Figure 2-3).

Figure 2-3. Comparison of World Capture Fisheries and Aquaculture Production 1950-2012



Source: FAO 2014.

Currently, approximately half of the world's supply of food fish comes from aquaculture. This percentage is expected to increase to nearly two thirds by 2030, however, as catches from wild capture fisheries plateau and demand from an emerging global middle class, especially in China, increases (World Bank 2013). In fact, Asia (e.g., South Asia, South-East Asia, China and Japan) is projected to account for 70% of the global fish consumption by 2030, while China alone is expected to represent nearly 38%.

At 4.5 billion pounds, the U.S. currently ranks third in the world, behind only Japan and China, in its total annual consumption of fish and shellfish (NOAA 2012). Although per capita consumption has declined slightly in recent years from a high of 16.6 pounds to 14.4 pounds (Table 2.1), consistent evidence showing the health benefits of consuming seafood prompted the most recent federal Dietary Guidelines for Americans (USDA 2010) to recommend that individuals more than double their current seafood consumption by increasing their intake to at least 8 ounces a week.

Despite these demands however, America's aquaculture industry supplies only 5% of the current domestic demand for fish and shellfish, and the U.S. has remained only a minor aquaculture producer on the world stage (FAO 2014). According to the FAO, the U.S. currently ranks 15th in total aquaculture production behind China, India, Viet Nam, Indonesia, Bangladesh, Norway, Thailand, Egypt, Chile, Myanmar, Philippines, Brazil, Japan, and South Korea (FAO 2012). Additionally, about 70% of all U.S. aquaculture produced is of freshwater species (e.g., farming of tilapia, catfish, and trout); marine aquaculture currently supports only 1.5% of the domestic seafood demand (NOAA 2012). Molluscs such as oysters, clams, and mussels, currently make up two-thirds of the total U.S. marine aquaculture production. This is followed by salmon (about 25%) and shrimp (about 10%).

Table 2.1. U.S. Annual Per Capita Consumption of Fish and Shellfish

Year	Fresh and Frozen	Canned	Cured	Total
2003	11.4	4.6	0.3	16.3
2004	11.8	4.5	0.3	16.6
2005	11.6	4.3	0.3	16.2
2006	12.3	3.9	0.3	16.5
2007	12.1	3.9	0.3	16.3
2008	11.8	3.9	0.3	16.0
2009	12.0	3.7	0.3	16.0
2010	11.6	3.9	0.3	15.8
2011	10.9	3.8	0.3	15.0
2012	10.5	3.6	0.3	14.4

Note: All numbers refer to pounds of edible meat
Source: NOAA 2012

Worldwide, most expansion in aquaculture to date has occurred in nearshore marine and inland (freshwater) waters (e.g., farming of tilapia, catfish, and trout) (Kapetsky et al 2013). However, development in these areas is hampered by competition with other users (e.g., port developments and shipping, recreation, tourism), poor water quality, and environmental concerns (e.g. habitat sensitivity). These constraints have prompted efforts in several countries, including the U.S., to develop methods for aquaculture farther offshore, where water quality is generally better and conflicts with other uses and impacts to the environment are minimized. In particular, within the U.S. there is a drive to develop aquaculture in federal waters, or the U.S. Exclusive Economic Zone (EEZ), which consists of the ocean waters that are 3 to 200 miles from the coastline.

Efforts to develop more offshore aquaculture began over 30 years ago when U.S. Congress passed the National Aquaculture Act of 1980, and have more recently been supported by various Aquaculture Plans and Policies developed by the National Oceanic and Atmospheric Administration (2006-2014). The acknowledged need for developing and expanding aquaculture in U.S. waters, combined with the technology now available, which makes development further from the coast, in deeper waters, possible, provides the basis for the proposed project.

2.2 Project Team

Hubbs-SeaWorld Research Institute (HSWRI) is a non-profit research foundation established in 1963. The Institute's mission is to "*return to the sea some measure of the benefits derived from it.*" Over the past five decades, HSWRI has provided global leadership in marine conservation research, including extensive studies in marine aquaculture, which has been a core program for more than 35 years.

HSWRI is a national leader in the hatchery production of marine finfish and operates a production-scale hatchery in Carlsbad, California capable of rearing millions of fingerling white seabass per year (Figure 2-4). This is a cooperative program with the California Department of Fish and Wildlife (CDFW), with all seabass produced being released into the ocean to replenish wild stocks. Each fish has to meet the highest standards of quality in terms of appearance, health and genetic diversity.

Figure 2-4. HSWRI hatchery in Carlsbad, CA.

HSWRI also operates a research-scale hatchery in San Diego for rearing other commercially valuable species – both for replenishment and marine farming. Both of these hatchery facilities use state-of-the-art, energy efficient life support systems and are operated to comply with California's rigorous permit requirements.

HSWRI has also worked with cage systems for growout of juvenile fish since 1991. In 1997, HSWRI received a federal grant to expand its work by establishing a four-cage system off Santa Catalina Island where white seabass were grown to a weight of 1 kg (2.2 lbs) before being harvested and test-marketed (Figure 2-5). The results were encouraging, and significant market potential was recognized. HSWRI also operates two other cage systems and coordinates the activities of twelve other volunteer-based growout facilities in southern California for the replenishment of white seabass stocks.

Figure 2-5. White seabass (*Atractoscion nobilis*)

In 2007 HSWRI began an offshore aquaculture project in collaboration with Mexico's largest bluefin tuna farm, Maricultura del Norte, in Ensenada, Baja California, Mexico, approximately 96 km south of San Diego. This project evaluated two species of marine fish – yellowtail jack and striped bass, as well as two different cage designs. In 2010, HSWRI expanded upon this work evaluating soy-based diets for yellowtail jack and white seabass with Pacifico Aquaculture off the coast of Ensenada on their Todos Santos Island site.

RCF understands the need for increased production from ocean farms to meet worldwide demand for seafood and to alleviate fishing pressures on wild populations, and intends to conduct research and development to fully test the viability of commercial-scale aquaculture in the offshore environment. This will begin with a commercial fish farming project that builds on over 50 years of marine conservation research at HSWRI, including nearly 30 years on the production of fish in net pens. The RCF-SAP promises immediate commercial viability, which will make it possible to attract the investment necessary to develop the farm and supporting infrastructure within southern California. Additionally, once this is in place, RCF plans to use the farm site to develop other related aquaculture activities around the farm, such as mussel and seaweed cultures, that will seek to integrate production from both operational and environmental standpoints.

As detailed in Appendix I, HSWRI and CdM have experience in several other branches of aquaculture research and development that will be valuable in the execution of the proposed RCF-SAP, including:

- Hatchery methods including broodstock management, larval rearing and live feeds production
- Offshore cage farming methods including transportation of fish and operation of both surface and submersible cages
- Fish health
- Nutrition
- Physiology
- Reproduction
- Fish marking, tagging and tracking
- Genetics
- Site selection and permitting
- Environmental monitoring
- Hatchery and farm systems design and engineering; and
- Developed methods for raising several marine finfish species as part of programs to examine the potential for wild fishery replenishment and/or commercial farming

CdM is a U.S.-based investment firm that explores, develops, and supports open-ocean aquaculture methods that are economically viable as well as environmentally sustainable. CdM creates opportunities for development and use of innovative technologies that provide solutions to working in the open-ocean environment, and seeks investment opportunities with early-stage companies to develop new business opportunities. CdM plays an active role in the business of all of its portfolio companies by providing financing, governance and advisory services.

2.3 Project Scope

The proposed project will apply a phased approach to the development of a commercial-scale fish farm in the U.S. Exclusive Economic Zone (EEZ) offshore of southern California. The project will aim to produce a maximum of 5,000 metric tons (MT) per year of yellowtail jack or other species to be sold domestically. Initially the farm will be stocked to produce 1,000 to 1,500 MT annually of product at peak harvestable biomass. The farm will operate in this capacity while all aspects of production are closely monitored and documented. The project is then phased to scale up incrementally with a steady state of production from approximately eight years and beyond. A clearly defined expansion of farm capacity would be allowed after an appropriate environmental evaluation is completed. Demonstrating the efficacy of the venture at the initial level of production will ensure that all the proper safeguards are in place before scaling up further. The driving force and timeliness of the plan stem from several key business considerations:

- U.S. demand for seafood from aquaculture is growing rapidly, as demand cannot be met from either domestic harvests or existing farms.
- HSWRI and CdM are national leaders in the technology for producing marine finfish – both at sea and on land.
- Equipment is now available that makes farming possible in unsheltered waters off the southern California coast.
- HSWRI's reputation as a responsible marine research institution and steward of the marine environment will ensure that the venture is managed properly.
- HSWRI and CdM collectively have an outstanding team of aquaculture specialists and advisers who are well qualified to implement the project.
- The waters off southern California offer possibly the best marine growing conditions for yellowtail jack and other temperate water marine fish, as well as mussels and seaweeds.
- The species proposed for this venture are all regionally important species to California with well-established markets.

Inherent in the project design is the ability to assist government regulatory agencies and the lay community in developing national aquaculture guidelines through extensive, proactive monitoring and reporting programs. Increased initiatives at the national level, increased demand for seafood and commercial enterprise development are all driving forces that will help to expand aquaculture into the offshore environment. The operational knowledge gained from this project will be directly applicable and serve as a model for the responsible development of sustainable offshore aquaculture in the U.S.

2.4 Project Approach

The proposed project will grow yellowtail jack (*Seriola lalandi*), or other local species such as white seabass and striped bass, one species at a time, in open-ocean cages 4.5 miles (7.2 km) from shore. The resulting seafood products will be available in the freshest form possible, on-demand, and with an assurance of quality unavailable from a harvest fishery or foreign aquaculture.

Yellowtail jack has been chosen as the initial species as cultured juveniles are readily available from HSWRI hatcheries. Hatchery technologies also already exist for the other proposed species and, as the project progresses, these species will be integrated into the project. Once the project is operational, future considerations could also include use of the farm site to develop other related aquaculture activities, such as shellfish and seaweed cultures that will seek to integrate production from both operational and environmental standpoints.

The project will employ state-of-the-art fish cages, nets, and mooring systems. The proposed cage types have been proven to withstand the rigors of exposed offshore environments, are commercially available. However, as technologies for offshore aquaculture continue to advance, the project will be flexible enough to incorporate new systems or other technologies that may improve production efficiencies. It will also create jobs, including new opportunities for commercial fishermen, and will ensure that the existing infrastructure for fish processing and distribution has a viable future. The project will also serve as a research platform for work with project collaborators, including, but not limited to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) and the National Ocean Service (NOS), the National and California Sea Grant programs, the Western Regional Aquaculture Center and other U.S. and international universities.

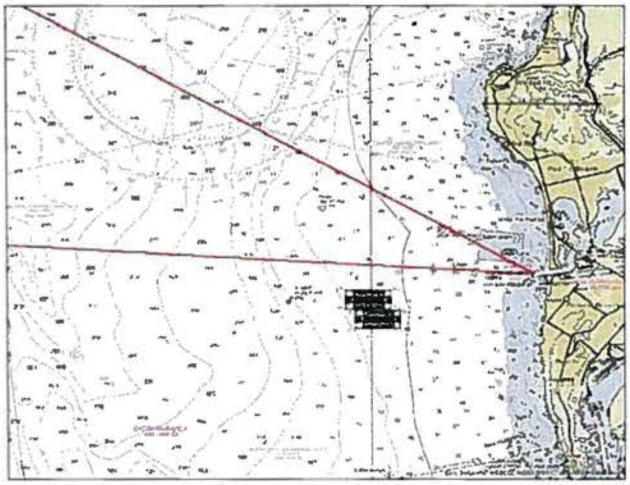
The harvested product will be available as fresh fish to seafood traders, brokers, wholesalers, retailers and restaurants both in southern California and throughout the U.S. Presently, as in the rest of the country, fish buyers in southern California are heavily dependent on imports, which, in the case of fresh fish, are often air freighted over long distances. Increasing fuel costs mean that this is now becoming more costly and there is increasing concern also about the carbon footprint imposed by air freight of fresh food, as recognized in the concept of 'food miles'. Therefore it makes both economic and ecological sense that seafood should be produced locally where possible. If the RCF-SAP is able to demonstrate both economic success and environmental compatibility so that the industry is able to expand, it would be a significant long-term contribution to the region's economy as well as to its ecological sustainability. Southern California is one of strongest markets for fresh seafood in the whole of the U.S. and the proposed RCF-SAP will be able supply the needs of the region both efficiently and effectively.

2.5 Site Description

A wide variety of criteria were used in selecting the project site, including depth, currents, temperature, substrate type and habitat, proximity to shore-based infrastructure, and avoidance of areas that would result in potential user conflicts (other commercial and recreational activities). HSWRI consulted with representatives from a variety of stakeholder groups, and collected and analyzed sediment samples, and used a bottom and depth sounder across the entire site location to ensure that there was no hard bottom or other habitat in the proposed area.

The resulting proposed project location is approximately 7.2 kilometers (4.5 miles) west of the entrance to Mission Bay in San Diego, CA and centered at Latitude 32°44.469'N, Longitude 117°19.931'W (Figure 2-6). The project site can be characterized as exposed, deepwater (~80m) coastal shelf. Bottom sediments in the project area are comprised primarily of fine particulates and fine sands, and reflect the presence of relatively strong surface and bottom currents.

Figure 2-6. Vicinity map showing site location and main navigational paths from Mission Bay to San Clemente Island (south) and Santa Catalina Island (north).



The location is remote from sensitive habitats such as nearshore kelp beds, rocky, hard bottom substrates, seal or sea lion haul outs, or other aquatic resource areas. The site is also located far from islands, seamounts, abrupt changes in bottom bathymetry, as well as from major navigational lanes.

In 2007-2008, HSWRI deployed an acoustic Doppler current meter at a previously proposed site located approximately 2 miles northwest of the currently proposed location. The meter was deployed for over 90 consecutive days to provide further insight on water column currents. Additionally, HSWRI collected and analyzed sediment samples, and used a bottom and depth sounder across the entire site location to ensure that there was no hard bottom or other habitat in the proposed area. This and other site and species information was then used by a third party consultant, Systems Science Applications, Inc. for integration into their proprietary modeling program, AquaModel to simulate water and sediment quality effects. A similar effort is underway for the current project site.

A Doppler current meter is currently in the process of being deployed at the proposed site and relevant benthic sampling is also underway. These data will be applied to an updated version of AquaModel, now an advanced 4-dimensional (Latitude x Longitude x Depth x Time) GIS fish farm simulation software tool. The model predicts water column and benthic effects of fish farm discharges and has been tested in inshore and offshore locations worldwide since 1991 (Rensel et al. 2007). A parallel modeling exercise will also be conducted using DEPOMOD, a Scottish origin software program that has been used for 15 years to provide guidance for permitting marine cage operations around the globe (Cromey et al. 2002; Cromey and Black 2005; Cromey et al. 2012). DEPOMOD predicts organic carbon deposition and accumulation beneath fish farms and estimates impacts on benthic invertebrate communities.

Results from the AquaModel and DEPOMOD simulations will: (1) demonstrate the value of modeling as a predictive tool for permitting and regulation; (2) guide siting, monitoring requirements, and best management practices (BMPs) for the proposed aquaculture operations, and (3) validate use of models as a proactive tool to provide stakeholders with high confidence in making space for aquaculture in the coastal ocean. Additionally, the proposed site is also being evaluated by the Bren School of Environmental Science and Management at the University of California Santa Barbara to analyze siting criteria for an aquaculture marine spatial planning project supported by NOAA's Sea Grant program.

2.5.1 Culture Systems

Cage Types. Three types of cage systems may be used for this project: traditional gravity type surface cages, traditional or Double Rim (DR) SeaStation cages, and Aquapod submersible fish cages.

A traditional gravity cage consists of a single or double ring collar made of high-density polyethylene (HDPE) pipe (Figure 2-7). The pipe is filled with closed cell flotation with a net suspended from the collar. HDPE type or steel type stanchions are installed at intervals around the ring to reinforce the pipe structures as well as support net systems, handrails and walkways. All cage equipment, including navigational aids are supported directly by the flotation structure. Gravity cages come in a wide range of sizes and associated volumes. This project will initially use gravity cages of up to 11,000 m^3 each and will incrementally be scaled to a maximum use of 24 cages per mooring grid, depending and in conjunction with the other cages.

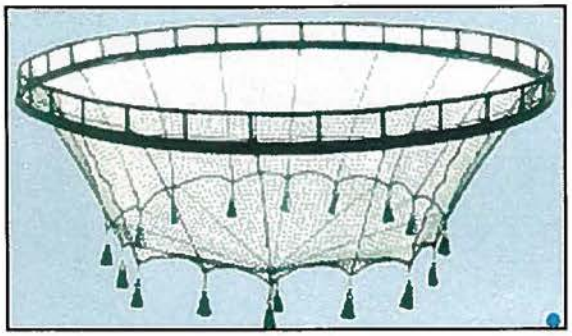


Figure 2-7. Illustration of a traditional gravity cage design

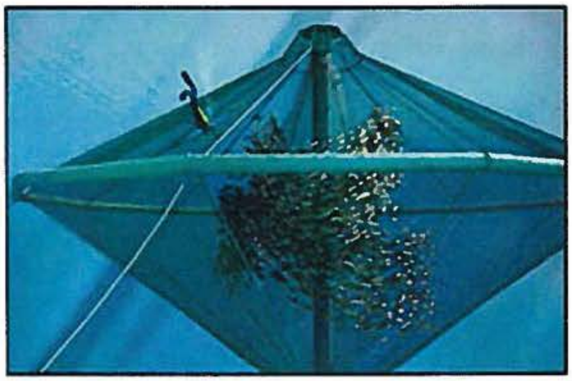


Figure 2-8. A traditional SeaStation fish cage

Traditional and Double Rim (DR) SeaStation fish cages are designed for large-scale submerged or surface operations (Figures 2-8 and 2-9). These cages are constructed with a galvanized steel framework that resembles a double cone "flying saucer". The central spar provides buoyancy and distributes loads to the net and circular tubular rim via radiating framing lines. The tubular steel rim maintains the net's shape and also has ballasting capabilities. The DR version of the design has two, vertically separated tubular rings, which increase the available depth and volume of the system. Nets and framing lines use high specification polymer fibres which maximize strength while reducing sectional dimensions and system drag. Different netting materials are available, depending on the operator's preferences. The Seastation cages provide excellent sea-keeping abilities in medium-

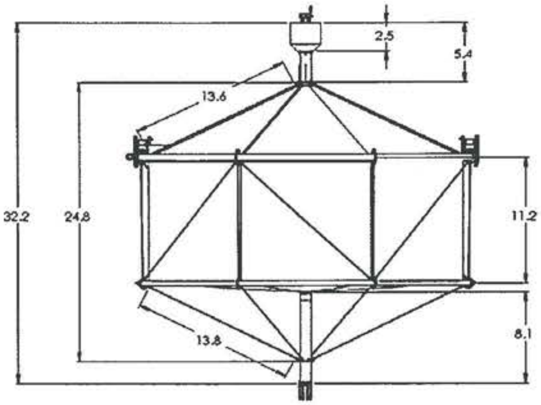


Figure 2-9. Illustration of a SeaStation Double Rim (DR) fish cage

to-high energy open ocean conditions and can weather major storm events. The design also allows for the surfacing of up to 50 percent of the pen's volume for harvesting and maintenance. These cages are currently being operated at commercial production levels in other parts of the world. RCF proposes using 11,000 m^3 cages and increasing the number of cages being used incrementally to a maximum of 24 cages per mooring grid.

Finally, the Aquapod fish cage is a rigid, fully submersible cage constructed of individual triangle net panels fastened together in a modular geodesic sphere (Figure 2-10). It acts as a secure containment system for finfish while submerged or partially surfaced, and is suited for rough open ocean conditions. Most Aquapod net panels are made of reinforced high density polyethylene with 80% recycled content and covered with coated galvanized steel wire mesh netting. Individual net panels or groups of panels can be modified to accommodate specific functions such as access, feeding, fish transfer, grading, and harvesting.

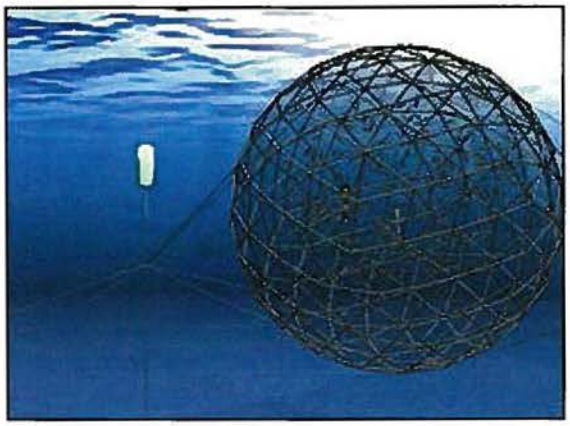


Figure 2-10. Illustration of an Aquapod submersible fish cage

Cage netting. Proposed nets and associated mesh sizes are standard in the industry, both in the U.S. and throughout the world. In contrast to submersible cages, which only require one layer of netting, for gravity type cages, each cage may have up to two types of nets depending on the net mesh material; if using nylon mesh, a primary net, which serves as the main containment net for the fish, and an anti-predator net, which acts as a barrier to the primary net and keeps predators at a safe distance (1 m) from the fish being cultured. All nets on gravity cages are weighted from the bottom. This keeps the nets taut so the desired culture volume is maintained and so animals do not become entangled. Primary containment nets will be suspended to a maximum depth of 12 m, with mesh sizes ranging from 0.95 to 2.85 cm square, depending on size of fish being cultured. Predator nets will be 8 cm square mesh and extend below the primary nets by a minimum of 1 m, and also above the cage collar by 2 m. Cover nets, or bird nets of 2.5-5 cm square mesh will also be stretched taut over the cage surface. These nets will be of high visibility color and supported with floating net rings to prevent birds from weighing down the net to the water surface.

Other types of cage netting, described below, may also be incorporated into the project. Depending on the system used, these alternative netting types can offer advantages over traditional netting in terms of strength and resistance to predators and biofouling.

Kikko Net mesh material is a Tetron plastic wire that can be molded into a variety of mesh sizes. Kikko Net is lightweight (1/6 the specific gravity of iron wire net); heavy strength to prevent continual tears because the structure is constructed using a special knitting method; anticorrosive; resistant to chemicals and sea water, highly resistant to acids. This makes Kikko Net ideal for usage in the sea. The strong material acts as its own predator exclusion mesh, removing the need for a secondary net. The nets are environmentally friendly as no harmful materials are included in the raw material, and nonconductive to electricity. Additionally, because Kikko Net is non-fibrous, fouling does not grow into the material itself making it easier to clean than standard woven fish netting.

Copper mesh material is used frequently now on a variety of farming operations. Although heavier than traditional woven fish netting and Kikko Net (requiring a more buoyant cage support system), copper alloy's resistance to fouling and strength make it an attractive option. In addition, copper netting resists storm damage and lasts longer than traditional netting, reduces predator attacks and fish escapes, stays naturally clean, reduces drag and maintains cage volume, decreases impact of pathogens and parasites, supports sustainable fish farming and is 100% recyclable and minimizes maintenance cost and efforts.

Mooring systems. One of two mooring grids capable of accommodating up to 24 cages each will be installed before installation of the first cages in order to optimize efficiency and cost. The primary portion of the mooring grid is submerged between 3 to 5 m below the surface and consists of professionally engineered anchors, chain, ropes, and assorted flotation structures. The grid and assembly is designed and installed using site-specific criteria such as depth, current, and bottom type. The final installation of the mooring grid will be perpendicular to the prevailing current direction in order to maximize flow of fresh seawater through the entire system. The cage equipment manufacturers as well as licensed maritime contractors will specify all mooring system configurations. Cage moorings will be inspected at regular intervals and after storm events. Plan and elevation view drawings of mooring configurations, as well as a site map are shown in Appendix II.

2.5.2 Culture Species

The species proposed for culture at the RCF-SAP are regionally important to California with well-established markets. Although yellowtail jack has been chosen as the initial species for culture (Figure 2-11), hatchery technologies also exist for the other species. As the project progresses, these species will also be integrated into production.

Yellowtail jack (*Seriola lalandi*)

Figure 2-11. Yellowtail Jack (*Seriola lalandi*)

This subtropical species is distributed worldwide and is currently cultured in Australia, New Zealand, Japan, and Baja California. It is particularly prized in sushi markets where it is sold as 'Hiramasa'.

Off southern California, yellowtail jack are a transitory, but seasonally abundant species that is valued both as a game and food fish. Captive broodstock are held at HSWRI's research facility in San Diego under ambient conditions and provide eggs in the spring and summer. HSWRI has conducted growout and marketing trials on this species from their Baja operations.

Farmed yellowtail has been described as being similar to Hawaiian kampachi (*Seriola rivoliana*) with a buttery texture and bright, mild flavor. This species also provides a slightly less fatty alternative to Japanese hamachi (*Seriola quinqueradiata*). The fat content is around 18-25%. The preferred market size is 4 kg; however the production cycle can range from 24-36 months, with fish taking longer to reach optimal size when reared in cooler water temperatures such as those that prevail in the project area.

White Seabass (*Atractoscion nobilis*)

Figure 2-12. White Seabass (*Atractoscion nobilis*)

Contrary to its name, white seabass (Figure 2-12) is not actually a seabass at all, but rather a type of large croaker. This species has supported recreational and commercial fisheries in California since the 1890s, and has been the focus of the nation's largest marine fish enhancement program, operated by HSWRI, since the 1980s. Four groups of captive broodstock are held at the HSWRI hatchery in Carlsbad under controlled conditions which provide eggs year-round. HSWRI has conducted extensive release, growout, and marketing trials on this species. The flesh is considered mild and slightly sweet with a firm texture. Minimum market size for this species is between 1-2 kg. Their production cycle can range from 24–36+ months depending on water temperature.

Striped Bass (*Morone saxatilis*)

Figure 2-13. Striped Bass (*Morone saxatilis*)

Striped bass (Figure 2-13) have a long culture history in the U.S., dating back to 1884. Although originally native to the east coast, they were introduced to California waters prior to the 1900s and commercial and recreational fisheries quickly developed. By the early 1970's, significant advances in hatchery technologies supported numerous hatchery facilities across the U.S. for stock replenishment purposes. Many of these hatcheries now support the commercial culture of striped bass and striped bass hybrids (white bass x striped bass). Market size for this species is between 1-2 kg. The meat of striped bass is considered firm but flaky and has a high oil content. Their production cycle can range from 24–36 months depending on water temperature.

2.5.3 Daily Operations

Fish will be fed several times per day with a dry pellet feed that is customized for each species under culture. The customization is designed to meet all the nutritional requirements of the fish, to promote maximum growth and food conversion efficiency leading to minimum production of waste, and to do this cost effectively. The size of feed is increased as the fish grow to optimize their feeding efficiency. The use of alternative sources of protein to reduce the level of fish meal in the diets is a priority and finishing diets may be used to adjust the flesh quality to match consumer preferences during the last several months prior to marketing.

The feed will be dispensed by automatic feeders that meter the precise amounts of feed delivered and which disperse it over as wide an area as possible in order to feed as many fish as possible at the same time. Feeding will be observed by fish farm technicians at the water surface and also by underwater video. In this way adjustments can be made continuously to ensure that feed is not wasted. Divers will also perform daily cage and system inspections to check for signs of system wear and to recover any dead fish. At regular intervals (typically every six weeks) throughout the production cycle, a sample of fish from each cage will be weighed and measured to track growth performance (biomass, feed conversion ratio, etc.) and to perform routine health inspections.

2.5.4 Net Cleaning and Maintenance

Nets in fish farms attract settling organisms that settle on the nets and grow there. Collectively these are usually referred to as 'fouling organisms'. It is essential that the growth of these organisms is kept in check so that the nets remain clean and water can flow freely through the net meshes. The RCF-SAP may use net cleaning devices to accomplish this. These devices are operated from the surface by lowering them on special harnesses or they can be attached to an ROV (Figure 2-14).

The cleaning heads work by using water pressure applied to a small section of net to dislodge fouling organisms and blow them to the outside of the net. By moving the heads up and down the net as shown in Figure 2-14, a complete net can be cleaned quite simply and, as the task is performed regularly, build-up of fouling organisms can be controlled so that the volume of debris removed at any one time is minimized.

Figure 2-14. Examples of net cleaning devices

Nets will also be replaced from time to time as fish grow and bigger meshes can be used, or when it is time for them to be brought ashore for thorough cleaning in a net washer and a detailed inspection for wear and to check the tensile strength of the twine and meshes. Other types of cage netting may also be incorporated into the project, depending on the type of cage system used. These netting types can offer advantages over traditional netting in terms of strength and resistance to predators and biofouling. See Section 2.5.1

2.5.5 Harvesting, Handling, and Packaging

Fish produced by the project will be harvested according to market demand, generally on a weekly basis. Fish will not be processed beyond whole or gilled and gutted product within the project infrastructure, but will be delivered by boat to shore and transferred to fish traders, brokers, wholesalers, or other pre-determined fish distribution outlets Product packaging typically consists of insulation-lined, appropriately labeled cardboard boxes, accommodating various amounts of fish per box, and kept chilled with fresh flaked ice, or gel ice packs, as determined by the purchaser. RCF will work with CDFW, the State Department of Health Services (SDHS), and the U.S. Department of Agriculture's (USDA) Food Safety and Inspection Service (FSIS) to develop an appropriate Hazard Analysis and Critical Control Point (HACCP) plan to monitor all product handling and maintain the highest quality assurance standards.

2.5.6 Feed Quality and Supply

Feed will be purchased only from well-established reputable manufacturers that have rigorous quality control standards. Several such manufacturers exist in the U.S. and Canada. The RCF-SAP management will also implement protocols to ensure that fish food is properly stored and that inventory is turned over at appropriate intervals. All feed shipments will be accompanied by a guaranteed chemical analysis certificate, and if purchased from Canada, an export certificate from the Canadian Food Inspection Service, and a U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) Veterinary import permit. Orders are placed far enough in advance to ensure an uninterrupted supply to support farm operations. HSWRI routinely sources high quality feed from the following manufacturers:

- Skretting, Vancouver, Canada
- Bio-Oregon, Inc., Washington, USA
- Nelson's Silver Cup, Utah, USA

Additionally, HSWRI is involved in many research studies evaluating alternative sources of protein to substitute for the fishmeal portions of fish feeds. The results of these studies will be integrated into the program as commercially available feed formulations are developed.

2.6 Environmental Monitoring

The U.S. Environmental Protection Agency (EPA), in conjunction with other federal and state agencies, is in the process of developing environmental standards and guidelines associated with aquaculture facilities. Impacts on receiving waters from offshore aquaculture facilities have not been characterized to date. This is largely due to the lack of offshore facilities but also due to the fact that offshore sites are typically associated with high energy environments that readily and efficiently disperse any effluent.

The RCF-SAP intends to work closely with the EPA, and other government agencies to assist in the development of offshore aquaculture effluent guidelines. To accomplish this, project staff will collect environmental data before, during and after the project.

Data to be collected for analysis will include sampling of water quality parameters such as: dissolved oxygen, temperature, salinity, ammonia, nitrite, nitrate, vertical visibility, and total dissolved and suspended solids. These parameters will be measured at the surface, mid-water column and just above the seafloor both upstream and downstream of the cages. They will also be measured inside the cages. Water quality samples will be collected with electronic probes as well as visual indicators. Benthic analyses will also be conducted. These will include the collection of sediment grabs for analysis of sediment grain size (% gravel, sand, silt, clay), redox potential, sulfides, copper, zinc, total organic carbon, and the resident infaunal community. Infaunal samples will be sieved, with organisms being identified to the lowest practical taxonomic level. Additionally, video transect surveys of the sea floor under and around the cages.

An acoustic Doppler current meter will also be deployed to collect baseline hydrographic data and to obtain an accurate understanding of year-round current patterns at the site. These data will be collectively analyzed and used to predict water flow and dispersal patterns for the site as well as aid in resolving any engineering issues associated with cage mooring and installations.

Best management practices (BMPs) will be developed in accordance with regulatory agencies for all cage operations and stringent health management and disease control programs will be implemented throughout the life of the project.

2.7 Regulatory Requirements

The project would require several regulatory approvals prior to construction and operation. Since the project is located in federal waters (i.e., >3 nautical miles from shore), regulatory approval is limited to federal agencies and those state agencies that have been granted jurisdiction by the federal government. For the purposes of this analysis, the following regulatory approvals would be required.

2.7.1 U.S. Army Corps of Engineers (ACOE)

The U.S. Army Corps of Engineers (ACOE) has regulatory authority over the proposed project under Section 10 of the Rivers and Harbors Act of 1899 (22 U.S.C. 1344). Section 10 of the Rivers and Harbors Act regulates the diking, filling and placement of structures in navigable waters. The ACOE has previously asserted authority under this statute and the Outer Continental Shelf Lands Act (43 U.S.C. 1331 et seq.) to require permits for open-ocean aquaculture facilities, specifically net pens, constructed in the U.S. Economic Zone beyond state waters (between 3 and 200 miles from shore). The purpose of these permits is to certify that the project will not impede navigation or negatively affect environmental quality. The RCF-SAP would result in the placement of anchors, lines, cages and buoys in navigable waterways, thus requiring ACOE approval.

2.7.2 U.S. Coast Guard (USCG)

Primary responsibility for the enforcement of U.S. maritime laws and regulations falls upon the U.S. Coast Guard. The USCG is responsible for managing and regulating provisions for safe navigation of vessels in U.S. waters, as well as the enforcement of environmental and pollution prevention regulations, including the Clean Water Act. The USCG also conducts pollution surveillance patrols to detect unauthorized discharges within the territorial sea and contiguous zone and has enforcement authority over violations. The RCF-SAP would result in the placement of anchors, lines, cages and buoys at a scale which will pose obstructions to safe navigation, thus requiring USCG approval and an Aids to Navigation permit.

2.7.3 U.S. Environmental Protection Agency (EPA)

The U.S. Environmental Protection Agency (EPA) has regulatory authority over the proposed project under the Clean Water Act (33 U.S.C. ss/1251 et seq.). The 1972 Federal Water Pollution Control Act and its 1977 amendments, collectively known as the Clean Water Act (CWA), established national water-quality goals and the basic structure for regulating discharges of pollutants into the waters of the U.S. The CWA also created a National Pollutant Discharge Elimination System (NPDES) of permits that specified minimum standards for the quality of discharged waters, and authorized the U.S. EPA to issue the NPDES permits.

Under NPDES, all point sources that discharge directly into U.S. waterways are required to obtain a permit regulating their discharge. Each NPDES permit specifies effluent limitations for particular pollutants (including total suspended solids), as well as monitoring and reporting requirements for the proposed discharge.

Specific to aquaculture, on June 30, 2004, the U.S. EPA completed regulations under the CWA establishing Effluent Limitations Guidelines (ELGs) and New Source Performance Standards for the Concentrated Aquatic Animal Production (CAAP) Point Source Category. These regulations contain requirements for wastewater discharges that must be met by new and existing CAAP facilities that directly discharge wastewaters to U.S. waters.

EPA's NPDES regulations define a hatchery, fish farm, or other facility as a CAAP by, among other things, the size of the operation and frequency of discharge (see 40 CFR 122.24 and Appendix C of 40 CFR Part 122 of the federal register). Specifically, CAAP facilities subject to the ELGs are defined as facilities (flow-through, recirculating, and net pen) that produce 100,000 pounds (45 MT) or more of aquatic animals per year. The proposed RCF-SAP will initially begin with a goal of 1,000 to 1,500 MT during the first production cycle, and will aim to increase production to 5,000 MT by year eight, so will be subject to the ELGs.

In the case of CAAPs, the ELGs require management practices and record-keeping activities, rather than numerical limits, although numerical limits may also be applied. The regulation is important in reducing discharges of conventional waste constituents (mainly total suspended solids), nonconventional constituents (e.g., nutrients, drugs, and chemicals), and to a lesser extent, toxic constituents (metals and PCBs) from CAAP facilities. For example, water treatments or algaecides used at a CAAP must be approved by the EPA and are regulated under the NPDES permit system. Compounds approved for use by U.S. aquaculturists are listed in the document "Guide to Drug, Vaccine and Pesticide Use in Aquaculture" which was written in 1994 and revised in 2007 by the Quality Assurance Working Group of the federal Joint Subcommittee on Aquaculture (JSA 1994, 2007).

The 2004 federal rule requires that all applicable facilities:

- Prevent discharge of drugs and pesticides that have been spilled and minimize discharges of excess feed.
- Regularly maintain production and wastewater treatment systems.
- Keep records on numbers and weights of animals, amounts of feed, and frequency of cleaning, inspections, maintenance, and repairs.
- Train staff to prevent and respond to spills and to properly operate and maintain production and wastewater treatment systems.
- Report the use of experimental animal drugs or drugs that are not used in accordance with label requirements.
- Report failure of or damage to a containment system.
- Develop, maintain, and certify a Best Management Practice plan that describes how the facility will meet the requirements.

The rule requires flow-through and recirculating discharge facilities to minimize the discharge of solids such as uneaten feed, settled solids, and animal carcasses.

The rule requires open-water system facilities to:

- Use active feed monitoring and management strategies to allow only the least possible uneaten feed to accumulate beneath the nets.
- Properly dispose of feed bags, packaging materials, waste rope, and netting.
- Limit as much as possible wastewater discharges resulting from the transport or harvest of the animals.
- Prevent the discharge of dead animals in the wastewater.

These rules are duplicative of existing state NPDES requirements in the states of Maine and Washington that also have numerical performance standards for soft-bottom habitats.

2.7.4 National Oceanic and Atmospheric Administration (NOAA)

The National Oceanic and Atmospheric Administration (NOAA) currently asserts authority over aquaculture harvests of federally managed species under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) of 1976. The MSA is the cornerstone legislation of fisheries management in U.S. jurisdictional waters. Its original purpose was to stop overfishing by foreign fleets and aid in the development of the domestic fishing industry.

The MSA gave the U.S. sole management authority over all living resources within the 200 nm (370 km) exclusive economic zone of the U.S., created eight regional Fishery Management Councils, and mandated a continuing planning and management program for marine fisheries by the Councils. The regional council for the project area is the Pacific Fishery Management Council. In accordance with the Act, the council reports directly to the U.S. Secretary of Commerce, who reviews, approves, and prepares fishery management plans. In practice, this function is delegated to the Administrator of the NOAA and the NMFS.

The MSA has been amended several times. In 1996, Federal law governing fisheries management underwent a major overhaul. The amendments, termed the Sustainable Fisheries Act of 1996, identified fish habitat as critical to healthy fish stocks and sustainable fisheries. The Act also implemented a program to designate and conserve Essential Fish Habitat (EFH) for species managed under a Fishery Management Plan. EFH is defined as "those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity." The intention is to minimize any adverse effects on habitat caused by fishing or non-fishing activities and to identify other actions to encourage the conservation and enhancement of such habitat.

Additionally, on June 9, 2011, NOAA and the Department of Commerce (DOC) released national aquaculture policies (NOAA 2011). These policies, based in part on the authority granted to NOAA by the MSA, the Marine Mammal Protection Act, the Endangered Species Act, National Environmental Protection Act, and the Coastal Zone Management Act, establish a framework to allow sustainable domestic aquaculture to contribute to the U.S. seafood supply, support coastal communities and important commercial and recreational fisheries, and help to restore species and habitat.

The RCF-SAP would result in the placement of anchors, lines, cages and buoys which could impact fish habitat at the project site, and thereby be subject to review by NOAA. NOAA's Sustainable Fisheries and Protected Species Divisions will also review the project for protected species, marine mammal, and other wildlife interactions.

2.7.5 California Department of Fish and Wildlife (CDFW)

The California Department of Fish and Wildlife (CDFW) requires the acquisition of an Aquaculture Registration Permit for every person/entity engaged in the controlled growing and harvesting of fish, shellfish and plants in marine, brackish and fresh water. As the RCF-SAP involves the controlled growing and harvesting of marine finfish, an Aquaculture Registration Permit for the facility will need to be obtained. This permit will also address the transport of young yellowtail jack (or other selected species) through California waters to the offshore site, and re-entry of the product back into California. In addition, it will allow CDFW oversight of the operation, including fish health inspections and other operational guidance.

2.7.6 California Coastal Commission (CCC)

The California Coastal Commission (CCC) retains permit jurisdiction over project areas on public trust lands, tidelands, and submerged lands from the mean high tide line to three nautical miles offshore. Although the project would be located approximately 4.5 miles (7.2 km) from the shoreline, it is acknowledged that development in waters beyond the 3-mile State limit can still impact waters within the 3-mile zone. Therefore, the California Coastal Commission would be required to certify that the project would be conducted in a manner that is consistent with California's approved Coastal Management Program (CCMP). Section 5 of this report provides a detailed discussion demonstrating consistency with the CCMP. Specifically, since the project requires a federal approval from the ACOE, a consistency certification pursuant to Section 307 (c)(3)(A) of the Coastal Zone Management Act (CZMA) is required for the project.

3.0 Scope and Approach to the Environmental Evaluation

The first step in the environmental evaluation is to determine what issue areas could be impacted by the RCF-SAP. An initial screening of a range of issue areas was conducted to assess the potential for environmental impacts. The results of this screening analysis are presented in Table 3.1. In addition, the geographic scope associated with each issue area was evaluated along with the time frame over which the issue area could be impacted.

The approach to the environmental evaluation was to identify issue areas where the RCF-SAP could lead to potentially significant environmental impacts above and beyond any existing impacts or influences identified in the environmental baseline. A review of the data presented in Table 3.1 shows that the issue areas where potential exists for significant environmental impacts from the proposed project to occur are: marine resources (biology, and water and sediment quality), commercial and recreational fishing, marine traffic, marine cultural resources and air quality. For all other issue areas, the baseline or ambient conditions would not be significantly affected by the RCF-SAP.

Table 3.1. Results of Issue Area Screening Analysis

Issue Area	Environmental Impact Screening Analysis Results	Geographic Scope for Issue Area	Time Frame for Impact Analysis
Marine Resources	The project has the potential to impact local water quality and marine biological resources in the immediate vicinity of the project. Anchors and anchor chains could impact benthic communities, while nutrient enrichment and wastes could impact water quality in the area. Increased transportation needs could result in collisions with marine animals, and the installation and operation of net pens could result in entanglements.	With the exceptions of disease or genetic dilution, most impacts would be limited to the vicinity of the project site.	Impacts would occur throughout the life of the project.
Air Quality	The project would not result in the direct emissions of air pollutants, however the project would require an 80-100 foot support vessel that will also provide 24-hour security at the site, and smaller supply vessels which would transport workers to and from the site. However, emissions associated with the support vessels would minimal, and would remain below significance threshold emission levels.	The air quality impacts would be limited to the San Diego County airshed.	Air quality impacts due to the project would be minor, but would continue for the duration of the project.
Onshore Geology	There would be no geologic impacts associated with the project since no new, land-based infrastructure would be needed.	This does not apply to the project since there are no impacts in this issue area.	This does not apply to the project since there are no impacts in this issue area.
Onshore Water Resources	There would be no onshore water impacts associated with the project since no new infrastructure would be needed, and no new water supplies would be needed for the offshore aquaculture operations.	This does not apply to the project since there are no impacts in this issue area.	This does not apply to the project since there are no impacts in this issue area.
Cultural and Historic Resources	There is the potential for cultural resource impacts associated with the project due to the use of anchors to secure the cages. While there are no known cultural resources in the project area, there are numerous historical shipwrecks in the region, many of which have not been located.	Potential impacts would be limited to the immediate vicinity of the project site out to a distance of approximately 1,000 meters.	Potential impacts could occur for the duration of the project if cages need to be repositioned.
Marine Transportation	Fish cages and anchor tag line buoys would have the potential to create navigational hazards and supply boat trips would be necessary to transport personnel and equipment. A larger support boat (80-100 ft) would also be needed for daily operations (fish feeding, security, etc.).	The geographic scope of the transportation impacts for the project would be limited to the area between Mission Bay and the project site.	The time frame for the transportation impacts from the project would be for the duration of the project, although most impacts would occur during the construction phase.
Recreation	Aside from recreational fishing, the project would not affect any existing recreational uses.	This does not apply to the project since there are no impacts in this issue area.	This does not apply to the project since there are no impacts in this issue area.

Table 3.1. Results of Issue Area Screening Analysis (continued)

Issue Area	Environmental Impact Screening Analysis Results	Geographic Scope for Issue Area	Time Frame for Impact Analysis
Land Use	There would be no land use impacts associated with the project since no new infrastructure would be needed.	This does not apply to the project since there are no impacts in this issue area.	This does not apply to the project since there are no impacts in this issue area.
Energy Use	The project would utilize an 80-100 foot support vessel for fish feeding and providing 24-hour security, a generator for local power requirements, as well as a smaller support boat to transport personnel on a daily basis. However, energy use associated with the support vessels would be below significance threshold levels.	Geographic scope is not applicable to energy use.	The life of the project.
Public Safety	Project-related equipment could increase navigational hazards in the immediate vicinity of the net pens.	Limited to an area of 1,500 meters from the net pens.	For the productive life of the project.
Public Services	There would be no public services impacts associated with the project since no new onshore infrastructure would be needed.	This does not apply to the project since there are no impacts in this issue area.	This does not apply to the project since there are no impacts in this issue area.
Onshore Biology	There would be no onshore biology impacts associated with the project since no new infrastructure would be needed.	This does not apply to the project since there are no impacts in this issue area.	This does not apply to the project since there are no impacts in this issue area.
Commercial Fishing	The placement of fish cages, anchors and anchor tag lines would result in a minor, but long-term, impedance of commercial fishing activities.	Limited to an area of 1,500 meters from the net pens.	For the productive life of the project.
Socioeconomic	The project would not have any socioeconomic impacts on the surrounding community. It has been estimated that a maximum of 70 workers would be needed to operate the facility. This would represent a negligible increase. Additionally, no new support infrastructure would be needed to support the project. There would be some minor additional transportation requirements (delivery of equipment and supplies); however, these additional transportation increases would be negligible compared to baseline levels.	The socioeconomic impacts would be limited to San Diego and the surrounding community.	The duration of the impact would be for the life of the project.
Environmental Justice	The only onshore area where there would be incremental impacts from the project's normal activities is Mission Bay. However, no new infrastructure would be needed; any increase in activity would be limited to the construction phase. Slight increases would also occur during fish harvesting and some routine daily activities that would provide an economic benefit to the area.	This does not apply to the project since there are no impacts in this issue area.	This does not apply to the project since there are no impacts in this issue area.

4.0 Proposed Project Environmental Evaluation

This section of the document presents the environmental baseline and project-specific significant impacts for the issue areas (Marine Biological Resources, Marine Water and Sediment Quality, Commercial and Recreational Fishing, Marine Traffic, and Marine Cultural Resources) that were identified as having the potential for new environmental impacts. For each issue area the potential impacts are discussed along with mitigation measures.

4.1 Marine Water and Sediment Quality

This section covers marine-water and benthic-sediment-quality issue areas. Excess feed, fecal material, and therapeutics generated by the net-pen system can impact both water and sediment quality, and are difficult to assess and control because of the widely distributed source region and the fluctuating nature of the ambient conditions. The severity of impacts that could result from the proposed project are largely determined by prevailing oceanographic conditions and water depth. For example, strong currents in deep, open ocean waters serve to enhance dispersal and dilute waste constituents generated by aquaculture operations. In contrast, locations with quiescent conditions, or pens located in enclosed areas, can result in localized buildup of waste constituents.

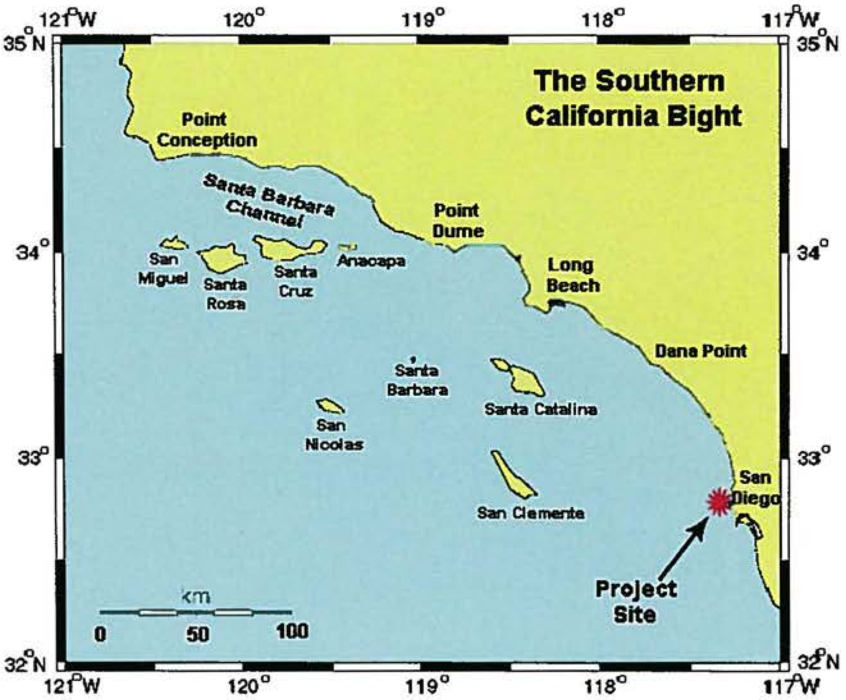
4.1.1 Oceanographic Setting

The proposed project area lies approximately 7.2 kilometers (4.5 miles) offshore the mainland California coast from San Diego's Mission Bay, within the southern portion of what is known as the Southern California Bight (SCB) (Figure 4.1-1). The SCB is a region that includes coastal southern California, the Channel Islands and the local portion of the Pacific Ocean. This region is referred to as a bight because the characteristic north-south trending coastline found off much of western North America experiences a significant curvature or indentation along the coast of southern California south of Point Conception.

The portion of the Pacific Ocean that occupies this region, from Point Conception in the north to just past San Diego in the south, and extending offshore of San Nicolas Island, is characterized by complex current circulation patterns, and a diverse range of marine habitats. Distributed between the mainland and the offshore islands are a series of submarine canyons, ridges, and basins, that provide some of the most unique marine habitats in the SCB.

The region has a mild Mediterranean climate (wet winter/dry summer seasonality of precipitation); more than 80% of the annual precipitation occurs from December through March. Total rainfall in the area during 2013 was approximately 6.55 inches, which was well below the historical average of more than 10 inches/year (NOAA/NWS 2008). Offshore air temperatures generally range from 50 to 65°F (10 to 18°C).

Figure 4.1-1. Project Location within the Southern California Bight

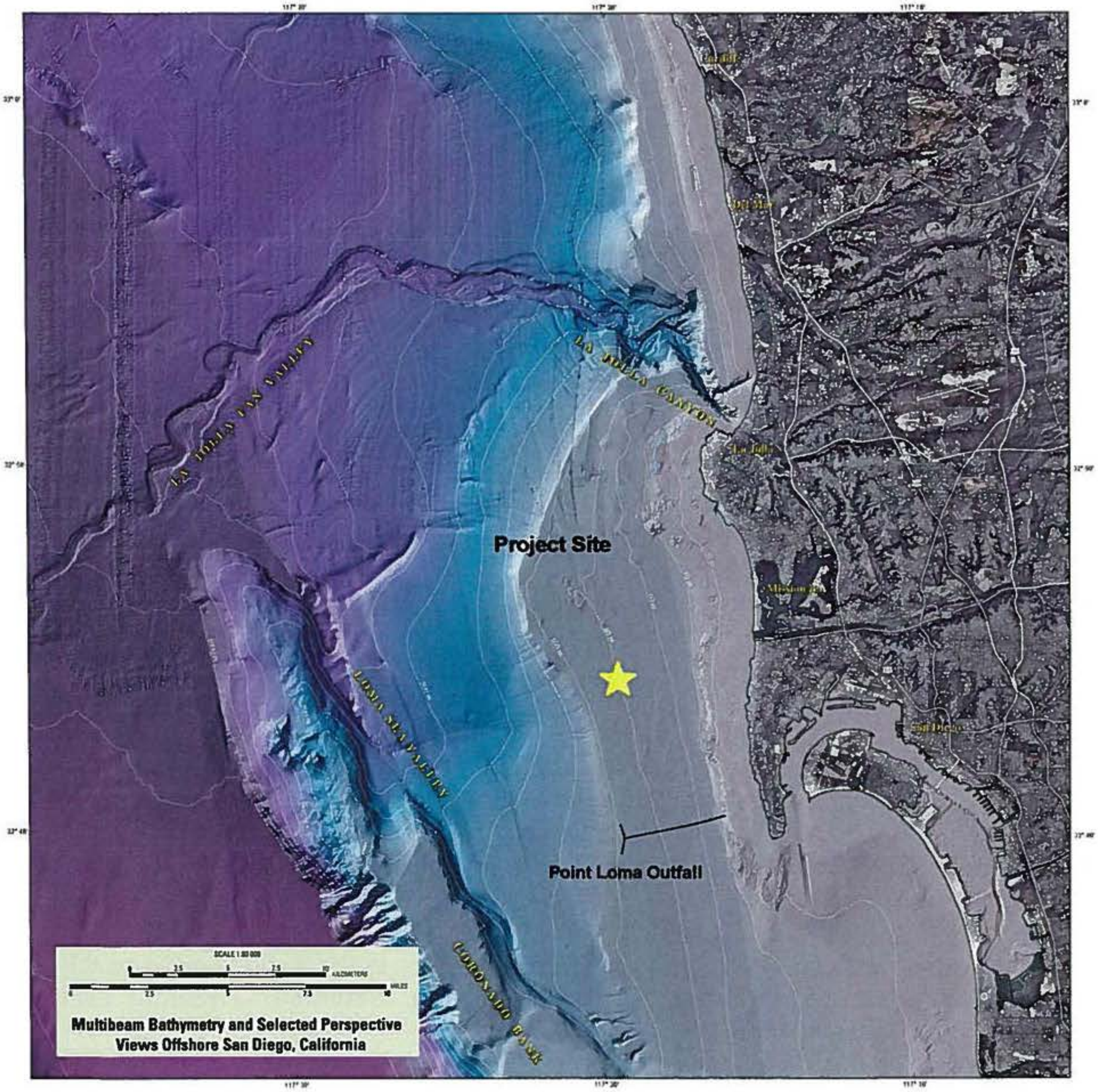


Source: Modified from Hickey, 1990. Progress in Oceanography V30: 37-115

The project site is located on the edge of the continental shelf, just above the start of the continental slope, about 7.2 km (4.5 miles) offshore from Mission Bay. Water depth in the proposed project area is approximately 80 meters (Figure 4.1-2). Major oceanographic features in the area include the La Jolla submarine canyon to the north, and the Coronado Bank to the southwest. Additionally, the discharge outfall for the Point Loma Wastewater Treatment Plant is situated approximately 10 km south of the proposed project site, along the 100 m isobath. In 1993, the outfall was extended approximately 6.4 km to its present length of 7.2 km, making it one of the longest and deepest (at almost 100 m) discharges in the world. Approximately 180 million gallons of wastewater treated at the Point Loma Wastewater Treatment Plant are discharged through the outfall each day.

Sea-surface properties at the project site are relatively stable with mean temperatures around 15°C and salinities near 33.5‰. Dissolved oxygen concentrations range widely, from over 10 mg/L at the sea surface, to around 2 mg/L near the sea floor (City of San Diego 2008, 2013, 2014, SIO 2008). Nitrogen, phosphorous, and silica are the nutrients that limit primary production in the ocean and all are usually depleted near the sea surface. Between May and July, upwelling events carry oxygen-poor nutrient-rich toward the sea surface along the adjacent coastline. The resulting increased productivity can reduce coastal water clarity as can onshore runoff during intense winter storms. During these periods, nearshore turbidity levels can reach 1.5 mg/L while offshore turbidity generally remains near 0.15 mg/L in the upper water column.

Figure 4.1-2. Project Location and Local Bathymetry Offshore San Diego, California



4.1.1.1 Ocean Currents

Circulation patterns within the SCB are well studied, but highly complex. Observations reveal many energetic, seasonally dependent flow regimes with diverse characteristics. They center around the California Current System, which is comprised of a southward meandering surface current, a poleward undercurrent and surface countercurrents (Table 4.1.1).

The SCC exhibits high biological productivity, diverse regional characteristics, and intricate eddy motions that have puzzled oceanographers for decades. Coastal upwelling along irregular coastlines and over strongly sloping topography generates a rich eddy field. High eddy kinetic energy obscures the measurement of mean flows, although surface-current observations from satellite-tracked drifters have shown large-scale mean equatorward surface flow and a concomitant surface eddy field (Swenson and Niiler 1996).

Table 4.1.1. Major Currents of the Southern California Bight

Name	**California Current**	**Southern California Countercurrent**	**California Undercurrent**
Direction of Flow	Equatorward	Poleward	Poleward
Depth	Surface (0-300m)	Surface/Subsurface	Subsurface (strongest over continental slope, 100-300m)
Width	Wide/Meandering (~1000 km)	Narrow (up to 100 km)	Narrow (10-40 km)

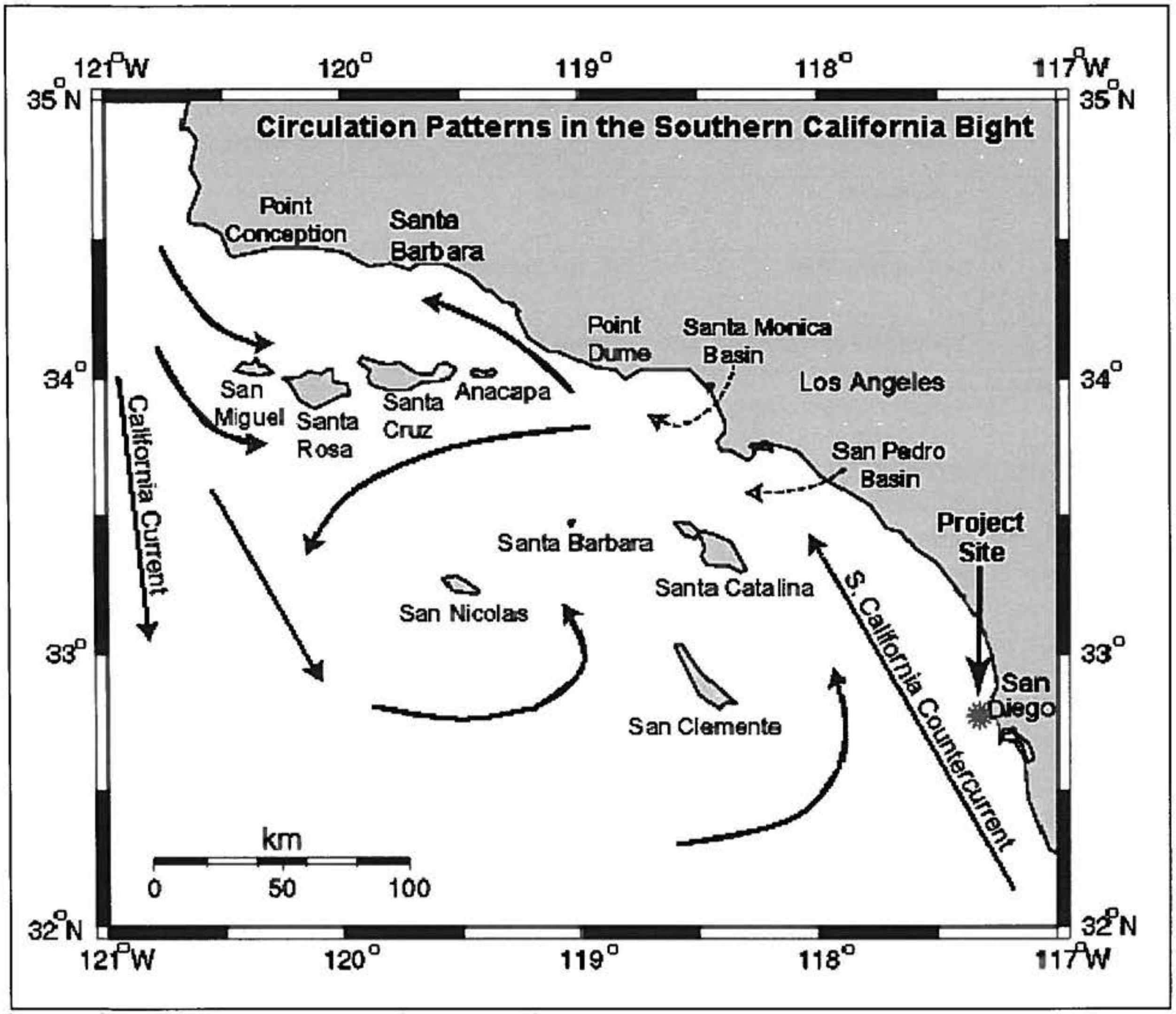
Source: After Batteen et al 2003.

The California Current (CC), an eastern boundary current of the North Pacific gyre, dominates flow in the region, and is strongest during summer. The CC flows equatorward (south) as a broad, cool, low-salinity, nutrient-rich, and slow- moving surface current (Table 4.1.1 and Figure 4.1-3). From Oregon south to Point Conception, the CC flows just offshore of the continental shelf edge out to approximately 900 km from shore, resulting in predominately cool coastal waters along much of California's northern and central coastline. The current is strongest at the sea surface, and generally extends over the upper 500 m of the water column with typical mean speeds of 10 cm/s (Hickey and Banas 2003). South of Point Conception, however, the shoreline cuts sharply to the east forming the Southern California Bight. Here, the CC flows south-southeast, passing along the continental slope roughly 160 km (100 miles) offshore (Figure 4.1-3). As it travels southward it interacts with the relatively stationary Bight water. This causes some of the CC to shear off, forming a poleward-flowing counter current in the Bight that begins at around 32° N. Additionally, during winter and spring, northwest winds can steer some of the CC directly into the northern portion of the SCB, forming vortices in the Santa Barbara Channel.

The counter-current flow stimulated by the CC moves poleward (north) past the Channel Islands and southern California mainland, transporting warm, equatorial waters (often poor in chlorophyll, which is commonly used as a proxy for estimating phytoplankton abundance) into the Santa Monica Basin and the Santa Barbara Channel (Figure 4.1-3). This current is known as the Southern California Countercurrent (SCC) or the Inshore Current since it seems to flow most strongly closer to the mainland coast. As seen in Figure 4.1-3, at the northwestern end of Santa Monica Basin, this poleward flow divides into two flows: one flowing northwestward through the Santa Barbara Channel, and the other flowing westward to the south of the northern Channel Islands (Hickey, 1992; Bray et al., 1999).

The intensity of the California Current System varies seasonally. During the winter and spring, equatorward winds accelerate the flow velocity of the CC, causing it to flow more jet-like, with little shearing taking place into the SCB. As a result, the SCC slows to its lowest velocity. During summer and fall, however, winds relax, reducing the velocity of the CC, and allowing more shearing from the CC into the water of the Southern California Bight. This increases the flow velocity of the SCC which in turn promotes eddy development within the Bight.

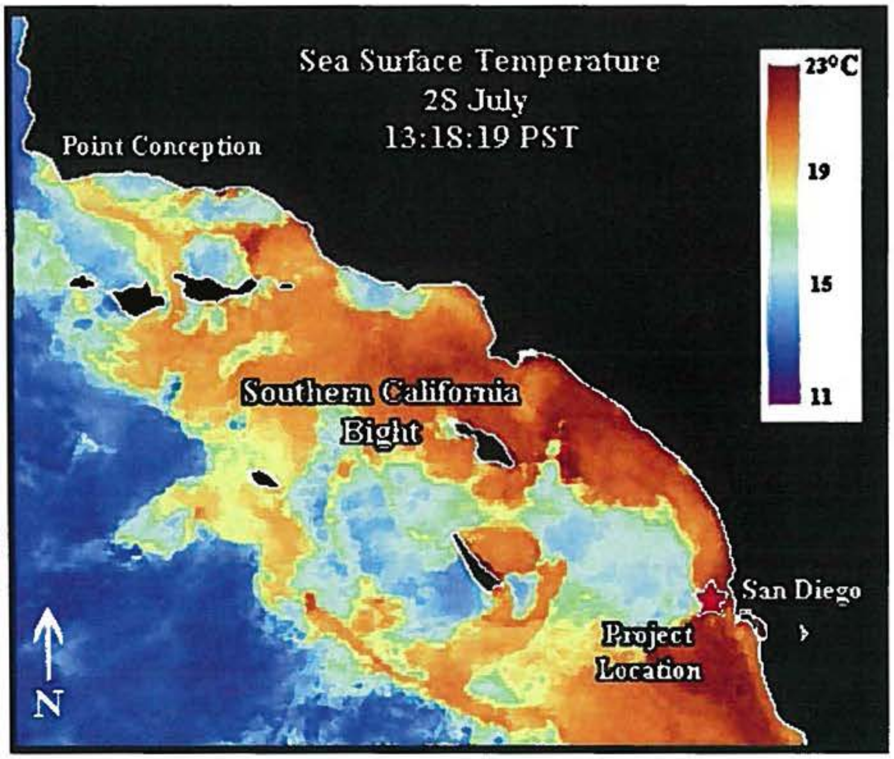
Figure 4.1-3. Circulation Patterns in the Southern California Bight



Source: After Hickey, B.M. 1992. Progress in Oceanography V30:37-115

The satellite image in Figure 4.1-4 was recorded by infrared sensors on one of NOAA's polar orbiting satellites. In this image, the cooler waters of the CC, with temperatures at or below 14°C, appear in dark blue or purple while the warmer, equatorial waters of the SCC appear as orange or red. As seen in Figure 4.1-4, the warm southern waters of the SCC penetrate further to the north and west within the Bight during the summer months, promoting cyclonic eddy development. In particular, a large, seasonal, counterclockwise cyclonic circulation may form that is known as the Southern California Eddy. In Figure 4.1-4 the Southern California Eddy appears as an almost circular ring of warm (orange) water in the image extending between San Nicolas Island in the south and the northern Channel Islands of Santa Rosa, Santa Cruz, and Anacapa. The presence and extent of the Southern California Eddy is highly variable. Numerous smaller scale eddies also occur in the Bight, and tend to coalesce in mesoscale and smaller fields during summer and fall.

Figure 4.1-4. Sea Surface Temperatures within the Southern California Bight



Source: Adapted from NOAA Coastwatch 2008

A third current, not readily apparent in either of the preceding figures is the California Undercurrent (CU). The CU is a relatively narrow (10-40 km) feature that originates near the equator off the coast of Baja California, and flows northward over the continental slope at depths of ca. 100 to 400 m (Table 4.1.1). This current travels beneath the SCC, hugging the slopes of the mainland and islands of the Bight. It flows within 150 km of the coast as opposed to the 850-900 km extent of the southward flowing CC. The flow appears to be continuous for distances of 400 km or more, and has been observed at locations ranging from Baja California to Vancouver Island, British Columbia. Although the CU is generally warmer than the overlying SCC water, its salinity is much higher, making it denser than the SCC. Within the Bight, the CU reaches a maximum flow velocity during the summer where it has been shown to reach peak speeds as high as 50 cm/s (Noble and Ramp, 2000; Pierce et al., 1996). However, current measurements off central California indicate continuous, year-round flow over the upper continental slope at depths around 350 m with an average speed of 7.6 cm/s. (Collins et al 2000).

4.1.1.2 Winds and Eddies

Winds in the SCB are generally weaker but highly variable compared to the rest of the California coast, experiencing significant daily and seasonal fluctuations. Northwesterly winds dominate the region year-round (offshore), but during winter the wind direction is more variable; from March to November northwesterly wind is steadier. Maximum wind speeds are observed in spring, and decrease during summer months (Bray et al., 1999).

As stated previously, the strongest equatorward winds are found during spring along most of the California coast. At this time, the California Current moves closer to shore and becomes increasingly jet-like, with little shearing into the Bight. Flow within the Bight is then predominantly equatorward. Thus, poleward flow in the SCB generally experiences a minimum during spring and a maximum in summer. Related to this, upwelling events within the SCB tend to be limited to winter and early spring; local upwelling during summer, while strong elsewhere along the California coast, is minimal in the Bight due to the protection provided by Point Conception from the northwest winds.

Temporally and spatially variable local winds, as well as eight nearshore islands and numerous coastal promontories, submarine canyons, basins, and ridges introduce complexity to these large-scale circulation patterns, particularly in the form of small-scale eddies that are typically under 50 km in diameter.

Small-scale eddies are recognized as common features in the SCB. Coastal upwelling along irregular coastlines and over strongly sloping topography such as those found in the Bight generates a rich eddy field. Eddies are more or less circular movements of water, somewhat similar to cyclonic storms in the atmosphere such as hurricanes and tornadoes. They can result from a variety of mechanisms, including current instabilities and topographic, tidal and wind forcing. The small-scale eddies found in the SCB have the ability to influence biological patterns in many ways: via lateral current transport of nutrients and/or phytoplankton, and also via eddy pumping, a mechanism whereby cold, nutrient rich waters are driven upward within an eddy, stimulating phytoplankton growth in surface waters. These eddies are not fixed, closed systems but vary in dimension and intensity with changes in forcing factors.

4.1.1.3 Flow Field

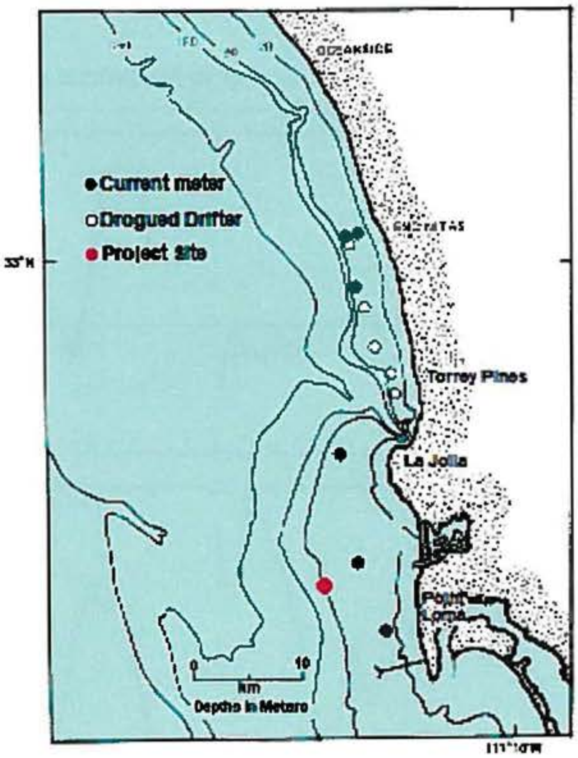
In general, poleward flow relative to 500 m is found throughout the SCB, in all seasons except for spring, and all subregions except the western part of the Santa Barbara Channel due to the influence of the California Current System (Bray et al 1999). In spring, there is equatorward flow throughout the SCB at all depths to 500 m, though it tends to be surface or midcolumn intensified.

In addition to being, flows near the coast are affected by a variety of forces and boundary conditions, including local winds, upwelling, lateral and vertical mixing, tides, freshwater inflow, solar heating, bathymetric changes and El Niño episodes. Coastal currents are separate from the large-scale Coastal Current System flow and are primarily forced by local winds. Wave heights are low in the area, ranging from 3 to 6 ft throughout most of the year.

Because of the complexity of the seasonal ocean current regimes, and the unique location of the project site at the lower boundary (32°N) of where the California Current generally shears eastward into the SCB, the flow field near the project site is characterized by intense, fluctuating currents. This was confirmed by a study carried out by the Southern California Coastal Water Research Project (SCCWRP) which analyzed the mean motion of subthermocline currents off Point Loma over the course of a full year, during 1976 (Hendricks 1976, 1977).

Current meters were placed off Point Loma, Mission Beach and La Jolla in approximately 56 meters of water as shown by the black dots in Figure 4.1-5. The current meter deployed at Point Loma recorded 290 days of data between 11 January and 31 December 1976. Shorter periods of time were captured at the other stations which then helped researchers determine the length of the segment of coast that could described by the currents recorded at a single location.

Figure 4.1-5. Current meter and drogue deployment locations during 1976 SCCWRP Study.



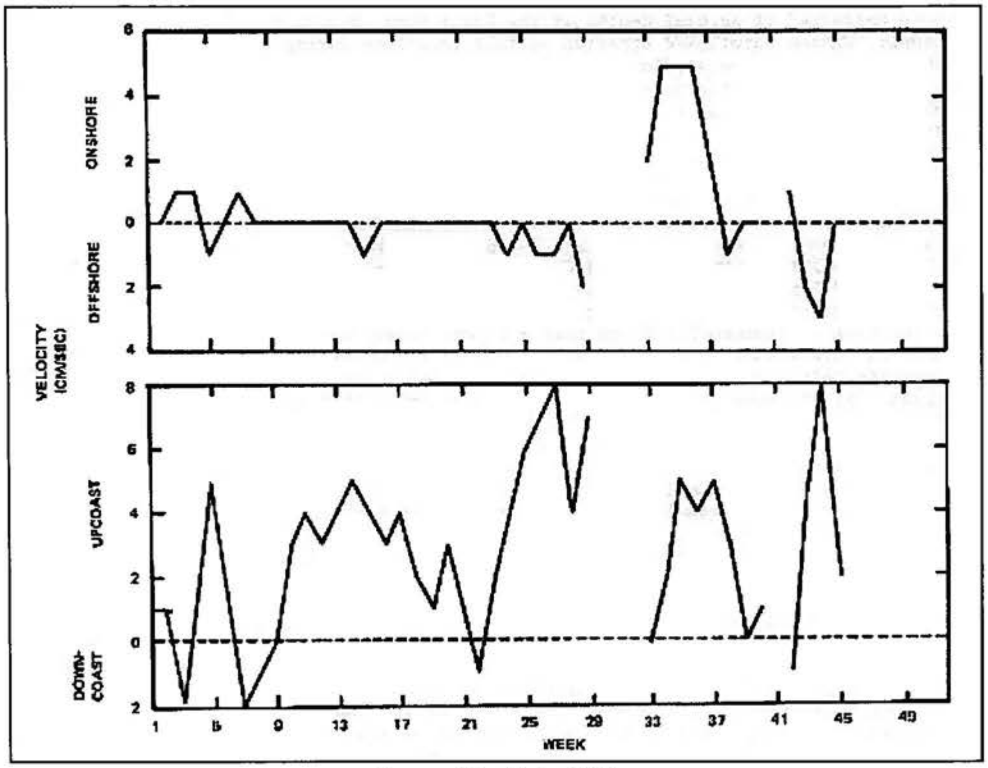
Source: Hendricks 1977

In addition to the current meters, five drogue drifters (white dots in Figure 4.1-5) were deployed off a 6 km segment of coastline along Torrey Pines. The drifters were deployed at 41 m in depth and were each found to move upcoast at roughly 7 to 10 cm/s along the local isobaths, even as near-surface waters were noted to be moving downcoast at over 25 cm/s. The drifter data indicated a high coherence in the regional currents and also exhibited a strong association with the current meter records, suggesting that current meter records taken off of Point Loma are likely a good representation of subthermocline currents all along the coastline in the project area. In this region, records collected along a 15 to 35-km segment of the coast indicate that the average daily currents are fairly similar throughout the area (Hendricks 1976, 1977).

The overall, alongshore movement of subthermocline currents throughout the survey was found to be upcoast (poleward) at a mean speed of 3 cm/s (Hendricks 1977). This net motion is in agreement with the distribution of effluent-related sediments in this area. However, a great deal of alongshore variability was superimposed on this mean flow (Figure 4.1-6). Meanwhile, in the onshore/offshore direction, the mean flow was essentially zero. A key result of this study was that the researchers determined that current meter records in this region may need to be taken for periods of at least two months to be able to definitively determine the direction (poleward or equatorward) of mean flow (Hendricks 1977).

Figure 4.1-6 shows the cross- and alongshore components measured at the Point Loma current meter station at a depth of 41 meters (bottom at 56 meters) of water during 1976. The values represent the net current over 2-week periods as calculated at weekly intervals. Of particular note is the fact that the subsurface current in this region is often opposite to that of the surface waters, which is primarily equator-ward, to the south.

Figure 4.1-6. The Ancillary Components of Currents Measured off Point Loma in 1976



Source: Hendricks 1977

Superimposed on the alongshore mean motion are much larger fluctuating motions that generally vary more slowly than the tidal oscillations for the alongshore component of the flow. In contrast, the onshore/offshore motions were much weaker, and are dominated by fluctuations of tidal periodicity. The fluctuations that are of shorter period than the tidal oscillations and those that are of longer period appear to contribute equally and, in together, are about equal to the tidal oscillation.

More recently, an acoustic Doppler current profiler (ADCP) was deployed at a site located approximately 2 km northwest of the proposed project site for a period of 96 consecutive days (14 December 2007 to 20 March 2008). The profiler collected data on current speed and direction throughout the water column, with the exception of the top seven meters at the sea surface[1]. The data collected and averaged from this meter determined there was a prevailing southerly current with an average speed of 8.3 cm/s. Over the course of the sampling period, the current measurements demonstrated a prevailing current heading south (168° to 188° T) with periodic reversals to a northerly heading (308° to 328° T). Mean surface and bottom current velocities during the deployment were 21.6 cm/s and 8.3 cm/s, respectively, with peak bottom current speeds of nearly 28.8 cm/s, and a reported peak surface current speed of 100 cm/s. As discussed previously, however, circulation within the Bight is fairly complex, and exhibits distinct seasonal variations.

An additional, even more recent source of insight into the prevailing flow patterns at the proposed project site can be derived from review of data collected for the Point Loma wastewater treatment plant's Ocean Outfall monitoring program. The Point Loma ocean outfall (PLOO) is located 8.45 km (5.25 miles) to the south of the project site, at a depth of approximately 100 m. In 1993, the outfall was extended approximately 6.4 km to its present length of 7.2 km, making it one of the longest and deepest discharges in the world.

As part of the long-term monitoring of the health of the outfall and surrounding waters, water quality parameters at thirty-six offshore stations are sampled quarterly to capture seasonal variations in oceanic conditions. One of the stations, Station F23, is located in the immediate vicinity of the proposed RCF-SAP site. In addition, an ADCP deployed near the outfall records current speed and direction while aerial and satellite image analysis is performed throughout the year to track the Point Loma discharge plume's presence and dispersion in the upper water column (≤15m).

Analysis of aerial and satellite images taken of the waters around the Point Loma discharge confirm that, consistent with historical data, surface flow in the region is predominantly southward throughout the year, with occasional northward flows occurring following storm events (City of San Diego 2008-2014, Hendricks 1977). For example, increased outflows from the Tijuana River near Imperial Beach and Los Buenos Creek in northern Baja California during the wet (winter) season can result in large northward-flowing turbidity plumes in San Diego coastal waters. Patterns in surface water turbidity resulting from these types of events indicate that northward surface current patterns are relatively common during the winter months, while southward surface flow with only occasional northward reversals dominates from April through December (City of San Diego 2008-2014).

Data collected from the ADCP deployed near the PLOO, at a depth of 100 m, during 2013 confirms this pattern (City of San Diego 2014). The data indicates that the general axis of current flow across the water column in the area was predominantly along a north-south axis with occasional flow along a northwest-southeast axis (City of San Diego 2014). Above 60m, although current flow alternated between north and south throughout the year, southward flow was more common in May and August. In contrast, at deeper depths (60–80 m), flow was predominantly to the north with much less oscillation, except during October, when flow was more to the south. Current velocities generally decreased with increasing depth. In the upper 10–

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[1] Due to the acoustic properties of the ADCP and its upward looking bottom deployment, reliable data were not collected or analyzed within 2.7 m of the seafloor and 7.3 m from the sea surface. (HSWRI 2008)

20 m depths, velocities varied seasonally, with higher velocities measured during the spring and late summer before decreasing during fall. At depths below 60 m, current velocities were generally slower, except for periods in late January and from late August through early September.

4.1.2 Water Quality

The proposed project could impact three types of water-quality parameters: nutrients, dissolved oxygen, and light penetration. Long-term measurements of these parameters have been made in the region as part of two separate monitoring programs: the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program (CalCOFI 2013), and the Point Loma Ocean Outfall (PLOO) monitoring program (City of San Diego 2014).

The CalCOFI organization was originally formed in 1949 to study the ecological aspects of the collapse of the sardine populations off California, but has since shifted its focus to the study of the marine environment and resources within the California Current System off the coast of southern California. Meanwhile, the PLOO monitoring program exists to monitor the health of the marine environment surrounding the Point Loma ocean outfall, which discharges treated wastewater effluent via a diffuser structure located on the seafloor 8.45 km (5.25 miles) south of the proposed RCF-SAP site. Much of the following discussion is derived from analysis of the raw data from these two programs, as well as annual monitoring reports compiled for the PLOO (City of San Diego 2008-2014).

Winter conditions typically prevail in southern California from December through February during which time higher wind, rain and wave activity often contribute to the formation of a well-mixed or relatively homogenous (non-stratified) water column. In late March or April the increasing elevation of the sun and lengthening days begin to warm surface waters, and seasonal thermoclines and pycnoclines become re-established. By late spring, the water column becomes stratified, and typically remains so throughout the summer and early fall months. In October or November, cooler temperatures associated with seasonal changes in isotherms, reduced solar input, along with increases in stormy weather, begin to cause the return of well-mixed water column conditions (City of San Diego 2014).

Data acquired from the PLOO monitoring program is derived from water quality sampling station F23, which is located in the immediate project area (Figure 4.1-7). This station is located along the 80 m isobath, and generally acts as northerly reference site for the PLOO monitoring program due to its distance from the outfall. Data is collected quarterly from this station, to capture the oceanic conditions during each season.

Figure 4.1-7. Proximity of project site to PLOO Water Quality monitoring sites

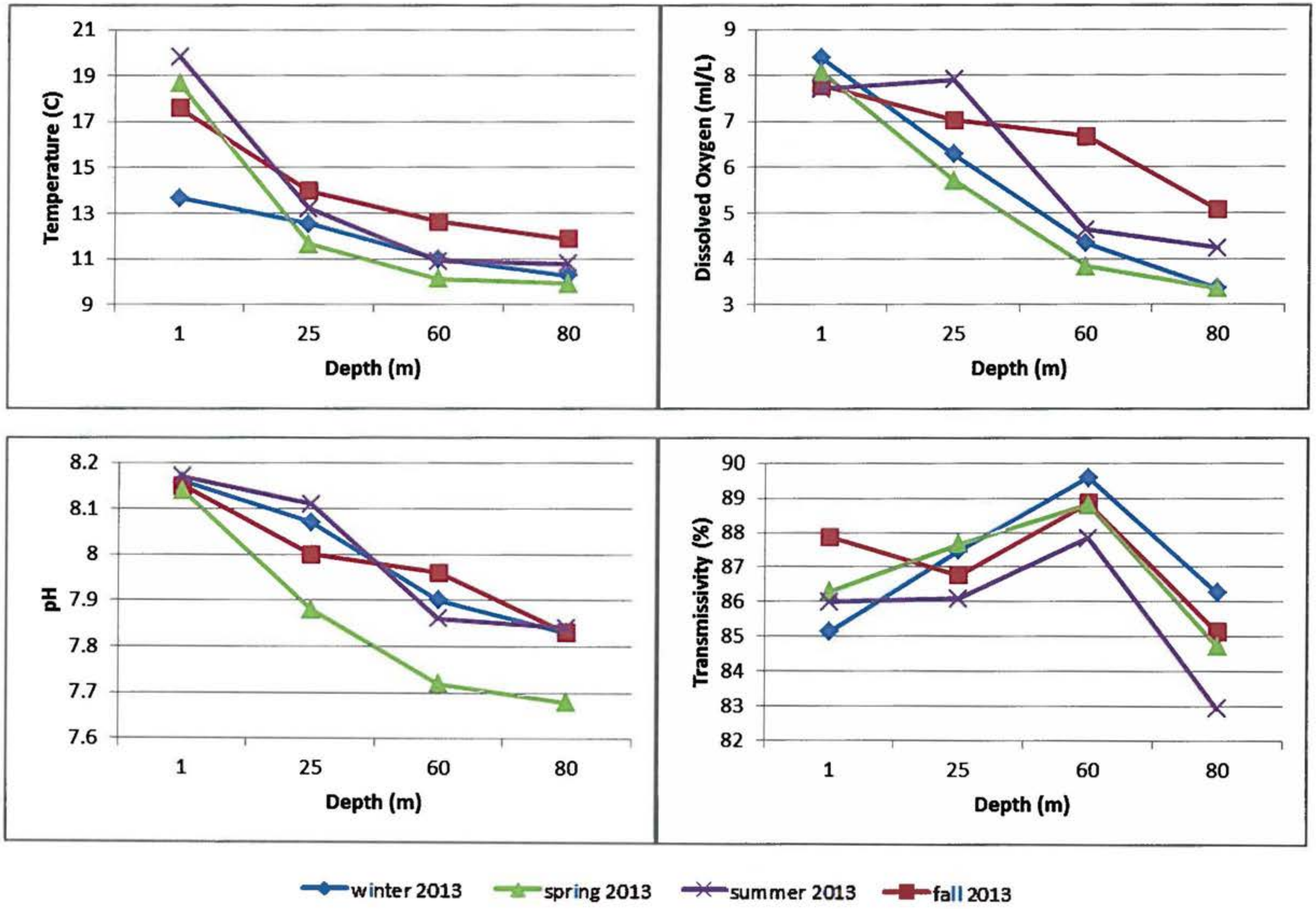
Source: RCF 2014

The PLOO monitoring program collects information on water temperature, dissolved oxygen, pH, salinity, density, transmissivity, and chlorophyll concentrations. Water temperatures in the project area generally range from 13 to about 21 degrees C at the sea surface (1 m depth) while temperatures at the sea floor (80 m) are lower, ranging from 10 to 12 degrees C (Figure 4.1-8a). Salinity increases slightly with depth, but generally remains between 33% and 34%. Thermal stratification follows seasonal patterns, with the greatest differences between surface and bottom water temperatures occurring during the spring (May) and summer (August) surveys when upwelling conditions may be present.

Peak chlorophyll concentrations are typically recorded in the upper water column, down to about the 25 m depth interval. Transmissivity levels typically mirror primary production, with uniformly high levels (~ 90%) at mid-depth, while values in the upper water column are highly variable but lower overall (Figure 4.1-8d).

Figure 4.1-8. Seasonal Vertical Water Quality Profiles Recorded at PLOO Water Quality Monitoring Station 23 during 2013

a) Temperature b) Dissolved Oxygen, c) pH, and d) Transmissivity



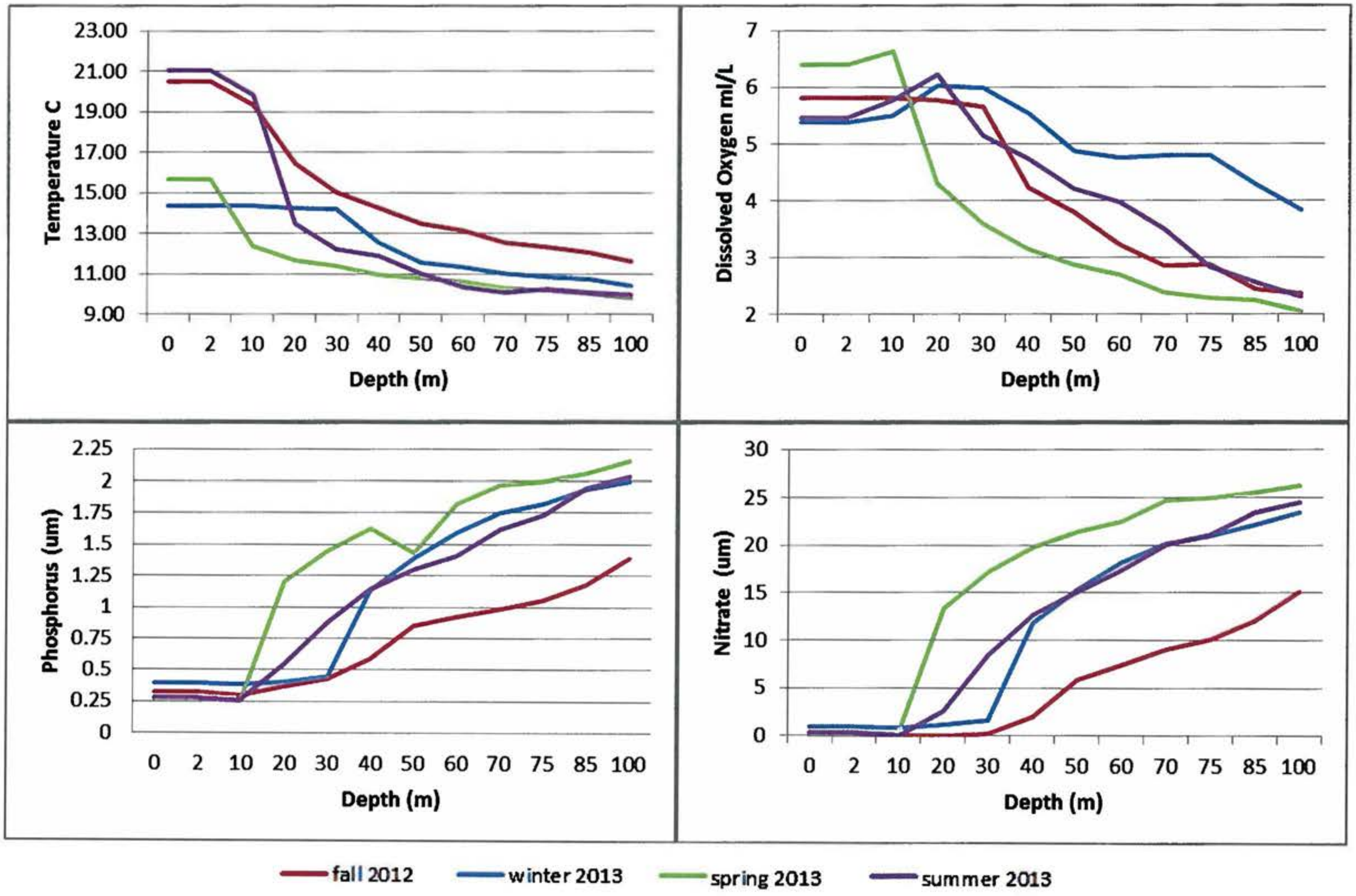
In the project area, DO and pH typically decrease steadily with depth (Figure 4.1-8bc). Surface DO values are generally above 7.5 mg/L, while mid-column and seafloor concentrations remain between 2 and 5 mg/L during most seasons. As with the other parameters, however, seasonal fluctuations do occur. For example, during the summer 2013 sampling, evidence of upwelling and primary productivity in the upper water column was marked by distinctly lower transmissivity values and elevated DO levels (Figure 4.1-8bd).

Similar to the PLOO monitoring program, but on a much larger scale, CalCOFI-organized cruises measure the physical and chemical properties and census populations of organisms at 75 stations extending in a grid from Point Conception to just north of San Diego. The nearest regularly occupied station (Station 28) to the proposed RCF-SAP site is located approximately 22 km (13 miles) to the north, northwest. Station 28 (32° 54.8 N, 117° 23.8 W) is regularly sampled for hydrographic data including temperature, dissolved oxygen, and nitrate and phosphate levels.

Figure 4.1-9(a-d) displays vertical profiles of ambient water-quality parameters measured at Station 28 during the latest four quarterly cruises for which data has been published (fall 2012 to summer 2013). Although water depths at Station 28 extend to approximately 400 m, the graph only displays data collected at depths comparable to those found at the project site (~100 m). These data show that dissolved oxygen concentrations are uniformly high and near saturation in the mixed layer at the sea surface, but decrease steadily with depth due to losses from biotic respiration and decomposition (Figure 4.1-8b). The rates of chemical and biological oxygen demand decrease exponentially with depth. As seen in the Figure, near the bottom of the seafloor at the project site (100 m), dissolved oxygen levels are likely to be around 2 mg/L, which concurs with the levels measured by the PLOO monitoring program.

Concentrations of phosphate (Figure 4.1-9c) and nitrate (Figure 4.1-9d) show that these nutrients are depleted in the surface mixed layer. This depletion results from uptake by primary production within the photic zone. Below the mixed layer, ongoing respiration and decomposition regenerates nutrient levels, and concentrations generally increase steadily with depth.

Figure 4.1-9. Seasonal Vertical Water Quality Profiles Recorded at CalCOFI Station 28 from fall 2012 to summer 2013: a) Temperature b) Dissolved Oxygen, b) Phosphate, and d) Nitrate



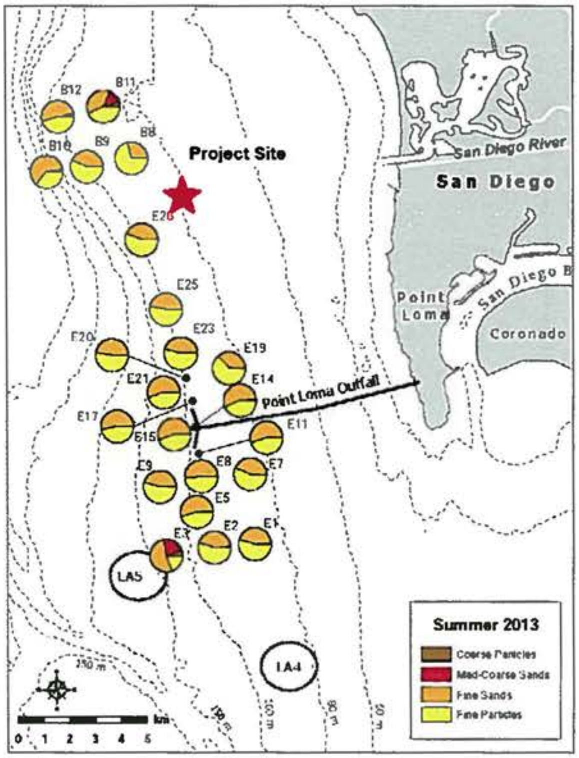
4.1.3 Sediment Quality

Chemical analysis of seafloor sediments provides insight into the overall health of the marine environment because environmental contaminants tend to accumulate on particulates that settle on the seafloor. They remain there for long periods and exert acute and chronic effects on the infauna that live on and in the sediments. For most chemical elements, natural background concentrations vary depending on grain size, carbon content, and mineralogy.

The project site lies within a well-studied region of the Southern California Bight. Results of recent benthic studies exploring both the deep benthic sediments of the continental slope, and nearshore coastal and embayment areas suggest little evidence of significant contaminant accumulation near the project site, while ongoing, long-term monitoring of the nearby Point Loma ocean outfall (PLOO) confirms that sediments in the proposed project area are relatively un-impacted (Stebbins et al 2006; City of San Diego 2014). Much of the following discussion is adapted or borrowed from the annual monitoring reports for the outfall (City of San Diego 2014).

Figure 4.1-10 shows the location of a series (22) of benthic monitoring stations that are part of the long-term monitoring program associated with the Point Loma wastewater treatment plant's NPDES discharge permit. The PLOO discharges effluent from a diffuser sited 8.45 km (5.25 miles) to the south of the proposed project site at approximately 100 m in depth. The plant conducts regular water column and benthic monitoring to demonstrate regulatory compliance with its discharge permit limits, and to ensure that the outfall is not unduly impacting the marine environment.

Figure 4.1-10. Particle Size Distribution at Benthic Monitoring Stations near the Project Site



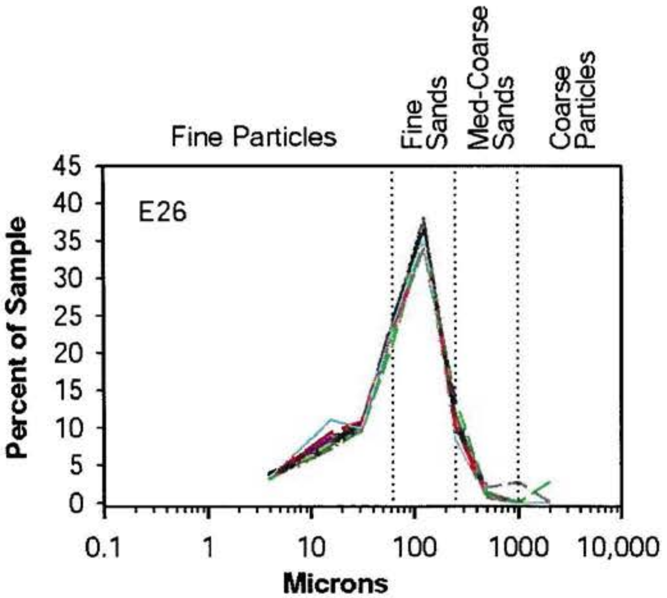
Source: Adapted from City of San Diego 2014

During 2013, semiannual surveys (January and July) of ocean sediments collected at the various sampling sites found that sediments in the region are predominantly composed of fine particles (i.e., silt and clay; also referred to as percent fines) and fine sands. Overall, percent fines ranged from 19 to 71% per sample, while fine sands ranged from 29 to 62%, medium-coarse sands ranged from < 1 to 22%, and coarse particles (e.g., black sand, gravel, pea gravel, rock and shell hash) ranged from 0 to 6%.

As seen in Figure 4.1-10, the nearest benthic monitoring stations to the proposed RCF-SAP are stations E26 and B8. Station E26 is located slightly closer (1.6 km) to the proposed project site, but at a greater depth (98m); Station B8 is located slightly further away (2.3 km), but at a depth (88m) that is closer to that of the proposed project. Because of their substantial distance (~10-12 km) from the outfall, stations B8, B9, B10, B11, and B12 are considered unlikely to be affected by effluent impacts, and act as reference stations for the PLOO discharge. For this reason, data from Station B8 provides additional valuable insight into the existing, baseline sediment conditions in the general project area.

Figure 4.1-11 depicts a breakdown of the particle size distributions collected at Station E26 from 2004 through 2013. The figure demonstrates that the grain size distribution in the project area is comprised of mostly fine sands and fine particles, and that the distribution has remained extremely consistent over the past decade (City of San Diego 2014).

Figure 4.1-11. Particle Size Distribution at Benthic Monitoring Station E26 from 2004 through 2013



Source: Adapted from City of San Diego 2014

During the summer 2013 sampling depicted in Figure 4.1-10, samples from both E26 and B8 were comprised of well more than 50 percent fines. In fact, Station B8 was comprised of the highest percentage (71%) of fines of any of the 22 monitoring stations.

During 2013, concentrations of various contaminants, including most indicators of organic loading (e.g., TN, TOC, TVS), 18 trace metals, pesticides, PCBs and PAHs were detected in local sediments at levels well within the natural range of variability for San Diego and other areas of the southern California continental shelf (see City of San Diego 2014, Schiff and Gossett 1998, Noblet et al. 2003, Schiff et al. 2006). Table 4.1.2 lists the mean concentration calculated for each chemical constituent monitored by the PLOO sampling program at their 22 benthic monitoring stations since 1991. Additionally, the table also lists the maximum concentration ever detected, and the overall detection rate for each constituent from 2004 through 2013.

To further assess whether sediment contaminant levels are environmentally significant, they can be compared with sediment guidelines advanced by the NOAA (Long and Morgan 1991; Long et al. 1995). These guidelines are based on correlations between chemical concentrations and observed biological effects. The NOAA guidelines identify Effects Range-Low (ERL) and Effects Range-Median (ERM) values.

Overall, the sediment characteristics displayed at the stations near the project site are considered typical of the mid- continental shelf, and are thought to reflect the multiple origins of sediments in the region. These data suggest that the project area is not subject to fast moving currents or large disturbances (e.g., storm surge, rapid suspension/deposition of materials) (City of San Diego 2014). With the exception of silver, which is present in relatively high concentrations throughout the region, and exceeded its ERM at station E26, concentrations at all sampling stations were well below the ERL (effects-range low), below which deleterious effects are not expected to occur.

Other sources of information on project area sediments include the "Bight '08" regional monitoring program, which is a continuation of regional surveys conducted in 1994, 1998, and 2003 that aim to quantitatively describe the health of coastal and embayment areas along the Southern California Bight (SCB) from Point Conception south to Baja California (Schiff et al 2011). As part of the original program, sites all along the Bight mainland were sampled and grouped into one of 4 categories based on their level of sediment contamination. Spatial distributions of site clusters based on the "Bight '98" sediment contaminant data indicated that the sediments near proposed project site did not show evidence of elevated metals concentrations. More recent sampling events have confirmed that sediments in the project area are typical of mid-shelf locations and do not appear impacted (Schiff et al 2011).

Table 4.1.2. Summary of Chemical Concentrations in Area Benthic Sediments from 1991-2013

Chemical Parameter	Mean Concentration among all Stations (1991-2013)	Maximum Concentration	Detection rate (2004 to 2013) (%)
Aluminum	9833	23200	100
Antimony	2.68	16.4	57
Arsenic	3.1	7.9	100
Barium	38.1	155.0	100
Beryllium	0.510	3,060	65
Cadmium	0.85	6.1	92
Chromium	17.1	43.6	100
Copper	8.1	82.4	100
Iron	13163	27200	100
Lead	5.91	67.60	100
Manganese	104	317.0	100
Mercury	0.03	0.093	100
Nickel	7.44	29	100
Selenium	0.25	0.90	19
Silver	1.30	7.60	39
Thallium	14.63	113.00	13
Tin	1.96	42.00	99
Zinc	28.8	176.0	100
BOD	301	980	100
Sulfides	5.4	127.0	97
TN (% weight)	0.051	0.192	100
TOC (% weight)	.64	4.85	100
TVS (% weight)	2.39	5.42	100
Total PCB (ppt)	2196	35690	18
Total PAH (ppb)	146.2	3062.6	48
Dieldrin	270	270	<1
Endrin Aldehyde	970	970	<1
HCB	406	1900	13
Total DDT	1417	44830	65
Total Chlordane	767	2000	1
Total HCH	370	370	<1

Note: all concentrations are in ppm (parts per million) unless otherwise stated.
Source: Adapted from City of San Diego 2014.

4.1.4 Regulatory Framework

4.1.4.1 Background

Current water-pollution restrictions in the U.S. were initiated by the 1948 Water Pollution Control Act, which focused on protection of human health rather than the environment. The Act allocated funds to state and local governments for water pollution control, placing emphasis on the States' role in controlling and protecting water resources, with few federal goals, objectives, limits, or guidelines.

Congress became increasingly concerned about water-quality degradation from 1956 through 1966, and passed four laws to strengthen the federal role in water-pollution control, including the Water Pollution Control Act Amendments of 1956 and the Federal Water Pollution Control Act Amendments of 1961. These initiatives directed additional funding to municipalities for construction of wastewater treatment works.

The Water Quality Act of 1965 required States to develop water quality standards for intrastate waters by 1967. The Water Quality Act also called for States to develop waste-load allocations to quantify pollutant loadings that could be discharged without exceeding the water quality standards. About half of the States developed water quality standards by 1971.

The President formed the U.S. Environmental Protection Agency (EPA) in 1970 to further enforce environmental compliance and consolidate federal pollution-control activities. The Refuse Act Permit Program (RAPP) was developed, under the 1899 Rivers and Harbors Act, as a new permitting program to control water pollution. The RAPP required any facility discharging wastes into public waterways to obtain a federal permit from the U.S. Army Corps of Engineers (USACE) specifying abatement requirements. The Administrator of the EPA endorsed the joint program with the Corps of Engineers, and on December 23, 1970, the permit program was mandated through Presidential Order. EPA and the Corps prepared the administrative and technical requirements for the permit program, but the technical basis for effluent limits was not always well founded. In December 1971, RAPP was struck down by a decision of the Federal District Court in Ohio.

In November 1972, Congress passed a comprehensive revision of federal water pollution control law, known as the Federal Water Pollution Control Act (FWPCA) Amendments of 1972. It was further amended in 1977 and is often referred to as the Clean Water Act (CWA). Title IV, Permits and Licenses, of the FWPCA Act created the system for permitting wastewater discharges (Section 402), known as the National Pollutant Discharge Elimination System (NPDES). Under NPDES, all facilities that discharge pollutants from any point source into waters of the United States are required to obtain a permit. The permit provides two levels of control: technology-based limits (based on the ability of dischargers in the same industrial category to treat wastewater) and water-quality-based limits (if technology-based limits were not sufficient to provide protection of the water body).

The USACE, under Section 10 of the 1899 River and Harbors Act, also continued to issue permits to structures located in navigable waters. Permits certify that the proposed project will not impede navigation or negatively affect environmental quality. The USACE has previously asserted authority under this statute and the Outer Continental Shelf Lands Act (43 U.S.C. 1331 et seq.) to require permits for open-ocean aquaculture facilities, specifically net pens, constructed in the U.S. Economic Zone beyond state waters (between 3 and 200 miles from shore).

The National Aquaculture Act of 1980, which applies to all federal agencies, states that it is "in the national interest, and it is the national policy, to encourage the development of aquaculture in the United States." To that end, there have been multiple attempts over the past two decades to develop formal regulatory policies for the development and operation and oversight of aquaculture in federal waters. To date, however, no definitive piece of legislation has succeeded in passing both the House and the Senate to become law.

4.1.4.2 Pending Aquaculture Regulations

In 1977, the EPA developed a technical guidance document that presented information on technology controls applicable to aquaculture operations. However, EPA shifted priorities to other sources of toxic metals and organics with the passage of the CWA Amendments in 1977. Although national standards were not actually developed, the CWA programs provide regulatory oversight to ensure discharges from aquaculture facilities are compatible with the environment. Because many forms of aquaculture are considered point sources, each source must be covered by a National Pollutant Discharge Elimination System (NPDES) permit. Discharge permits are developed by a state's environmental regulatory agency or by the EPA if the state does not have permitting primacy. Permits developed by EPA must receive a state's approval (401 certification) indicating the federally permitted discharge will comply with the applicable provisions of the CWA and state water quality standards will not be violated.

Any water treatments or algaecides used by an aquaculturist must also be approved by the EPA and are regulated under the NPDES permit system if they are considered a point source discharge. The Food and Drug Administration (FDA) also carefully scrutinizes drugs to ensure they are safe for the environment before they are approved for use in aquaculture. These approvals conform to the Federal Food, Drug and Cosmetic Act. Compounds currently approved for use by U.S. aquaculturists are listed in the document "Guide to Drug, Vaccine and Pesticide Use in Aquaculture" written by the Quality Assurance Working Group of the federal Joint Subcommittee on Aquaculture (JSA 1994, 2007). A revision to this document was published in 2007. More information on the applicant's fish health management strategy can be found in Appendix III.

Federal effluent guidelines for concentrated aquatic animal production (CAAP) facilities were promulgated in June 2004 after four years of public outreach, planning and industry review (USEPA 2004). The decision to expressly regulate aquaculture operations was the result of a 1992 consent decree by EPA. In January 1992, EPA agreed to a settlement with the Natural Resources Defense Council and others that established a schedule by which EPA would consider regulations for 19 industrial categories. EPA subsequently selected the CAAP industry for one of those rules. Presently, siltation, excessive nutrients, and pathogens are cited as the most prevalent causes of water quality impairments in the U.S. Therefore, EPA is shifting priorities to address sources of these pollutants.

In March 2007, the National Oceanic and Atmospheric Administration introduced the National Offshore Aquaculture Act of 2007 to Congress (H.R. 2010 in the House and as S. 1609 in the Senate). The purpose of the 2007 Act was to create a regulatory framework that allows for safe and sustainable aquaculture operations in U.S. federal waters. The 2007 Act included requirements to ensure that offshore aquaculture proceeded in an environmentally responsible manner consistent with stated policies for the protection of wild fish stocks and the quality of marine ecosystems, and was compatible with other uses of the marine environment. If enacted, The Act would have established a legal framework regarding permits, enforcement, and monitoring of aquaculture in federal waters with NOAA as the lead agency. A hearing concerning H.R. 2010 was held before the House Committee on Natural Resources, Subcommittee on Fisheries, Wildlife, and Oceans, but no further action was taken on either of these bills.

On January 28, 2009, the Gulf of Mexico Fishery Management Council voted to approve a plan to issue aquaculture permits and regulate aquaculture in the Gulf of Mexico (Gulf of Mexico Fishery Management Council. 2009). On September 3, 2009, the plan took effect because the Secretary of Commerce declined to oppose it within the required statutory period. However, many environmentalists and some fishing industry representatives have opposed the plan because of concerns related to environmental protection and potential negative effects on wild fish populations. Many of those who oppose the plan support a precautionary approach and development of national aquaculture standards.

On September 8, 2009, H.R. 3534, the Consolidated Land, Energy, and Aquatic Resources Act of 2009, was introduced. Section 704 of the bill would have rescinded the authority of the Secretary of Commerce, the Administrator of the National Oceanic and Atmospheric Administration, or Regional Fishery Management Councils to develop or approve fishery management plans to permit or regulate offshore aquaculture. Although H.R. 3534 was passed by the House on July 30, 2010, the section related to offshore aquaculture was excised from the bill.

On December 16, 2009, H.R. 4363, the National Sustainable Offshore Aquaculture Act of 2009, was introduced. The bill likewise sought to establish a regulatory system for offshore aquaculture in the U.S. Exclusive Economic Zone under the leadership of NOAA. The bill died in committee. A National Sustainable Offshore Aquaculture Act (H.R. 2373) was introduced again in 2011.

On May 25, 2010, S. 3417, the Research in Aquaculture Opportunity and Responsibility Act of 2010 was introduced. It would prohibit offshore aquaculture until three years after the submission of a report on the impacts of offshore aquaculture.

H.R. 7109 (2008), H.R 754 (2011), H.R.753 (2013) were each introduced with the goal of prohibiting the Secretary of the Interior and the Secretary of Commerce from authorizing commercial finfish aquaculture operations in the Exclusive Economic Zone except in accordance with a (future) law authorizing such action.

Most recently, on August 28, 2014, NOAA published a proposed rule for a Fishery Management Plan for Regulating Offshore Marine Aquaculture in the Gulf of Mexico (Gulf Aquaculture

Plan). The purpose of the Gulf Aquaculture Plan is to maximize benefits to the Nation by establishing a regional permitting process to manage the development of an environmentally sound and economically sustainable aquaculture industry in federal waters of the Gulf of Mexico. The Gulf Aquaculture Plan would allow up to 20 offshore aquaculture operations to be permitted in federal waters of the Gulf over a 10-year period.

4.1.5 Project Impacts and Mitigation Measures

Water and sediment quality impacts resulting from open-ocean aquaculture depend on the level of production, the intensity of the flow field, the depth of the water, and the assimilative capacity of the ambient receiving waters and benthic sediments. Aquaculture projects, particularly those in near-shore or semi-enclosed marine environments, have been criticized in the past for their contribution to localized degradation of water and benthic sediment quality. The use of net pens has been of particular concern because the contaminant input to the marine environment cannot be easily monitored, controlled, and filtered, as is the case with discharges from aquaria and other 'closed' systems. However, turbulent processes can rapidly disperse contaminants introduced by net pens when they are located in well-flushed, open-ocean sites as is the case for the proposed project.

Additionally, improvements in feed formulation and feeding efficiency over the past 20 years have significantly reduced nutrient loading in and near farms. Although impaired water quality may be observed around farms in nearshore or intertidal habitats where flushing is minimal, and at farms using feeds that include unprocessed raw fish rather than formulated feeds, neither of these is the case with the proposed project.

The following sections include a review of the possible marine water quality and benthic sediment impacts and mitigation measures associated with the proposed RCF-SAP. These and other potential impacts associated with aquaculture have been described at length in the literature, including Gowen and Bradbury, 1987; Silvert, 1992; Gowen and Rosenthal, 1993; Wu *et al.*, 1994; Wu, 1995; Buschmann *et al.*, 1996; Black *et al.*, 1996; Weston, 1996; British Columbia Environmental Office 1997; Nash et al. 2001; Normandeau Associates and Battelle, 2003; Waknitz et al. 2003; Brooks and Mahnken 2003 Nash and Waknitz, 2003; Nash 2003; and Price and Morris 2013.

4.1.5.1 Project Impacts

The major water-quality problems potentially arising from aquaculture activities include oxygen depletion in surrounding waters, degradation of benthic (bottom) ecosystems, and the potential exacerbation of toxic algae blooms through nutrient loading. Aquaculture wastes consist primarily of uneaten fish feed and fecal and other excretory wastes. They are a source of nutrient pollution consisting of carbon-based organic matter and nitrogen and phosphorous compounds. High nutrient levels can stimulate blooms of phytoplankton and algal populations. When algae die in large numbers, their subsequent degradation can also drastically reduce oxygen levels in the water column, stressing or killing fish and other organisms.

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Impact No. 1. Organic particulates discharged during aquaculture activities may locally degrade marine water quality.

The proposed project will introduce organic wastes into the marine environment that can be problematic when excess concentrations are artificially added to ambient levels in the upper ocean (photic zone). One or more key nutrients may become limiting in the environment, depending on the rates of supply and utilization. For example, primary productivity (plankton growth) in the euphotic zone of the ocean is generally limited by the availability of nitrogen (N), but also by phosphorous (P) and silica. In the SCB the N:P ratio in surface water is about 6, whereas the ratio in living phytoplankton is 16. This suggests that nitrogen is limiting in Bight waters (Eppley and Holm-Hansen 1986). Nitrogen and phosphorus will be introduced into the environment in feed and fecal wastes from the proposed project; fish excrete most of their waste nitrogen as ammonia in urine, while most phosphorus is tied up in fecal solid wastes.

Over the last decade, iron has also come to be recognized as an important trace-limiting nutrient in high nutrient–low chlorophyll (HNLC) regions, where unused macronutrients are persistently present in surface waters. Recent studies have also identified iron-limited regimes in coastal upwelling areas off California where the rapid movement of high-macronutrient waters into the well-lit surface layer results in iron limitation when no supplemental iron sources from continental shelf or terrestrial inputs are available (Hutchins et al 1998, King and Barbeau 2007, Hopkinson and Barbeau 2008). Thus, areas with a wide continental shelf tend to have waters that are iron-replete compared to areas with a very narrow shelf. Iron-replete and iron-limited waters also tend to differ in their associated phytoplankton communities and relative biomass at many trophic levels. The nearshore, coastal waters of the project site, however, are not considered iron-limited.

In semi-enclosed basins or where oceanic currents are weak and flushing limited (such as coastal estuaries), nutrient pollution (hypernutrification) has been found to cause eutrophication. Eutrophication occurs when algal decomposition drastically reduces dissolved oxygen to low levels (hypoxia) that can adversely affect fish and other marine organisms. The impact of hypernutrification from aquaculture facilities depends on a number of physical, chemical and biological factors, most notably the local hydrodynamics of the site.

Given the well-flushed nature of the proposed project site, the likelihood of significant eutrophication within the 80 m water column is highly unlikely. Near-surface current velocities measured near the proposed site using an ADCP in 2008 averaged 21.6 cm/s with 10 and 90 percentile flows of 7.3 cm/s and 36.9 cm/s. Although excess nutrients are not eliminated by dilution processes, as they would be in treatment or source reduction, dispersion by the highly variable alongshore currents present at the project site will rapidly lower nutrient concentrations, making them more easily assimilated into the local food web. Additionally, the energetic alongshore water movements characteristic of the project site will rapidly replenish any waters that become anoxic with oxygen-rich water from surrounding areas. Accordingly, studies have demonstrated that dissolved nutrients generated by aquaculture net-pen systems located in marine waters with strong currents are quickly diluted and tend not to cause hypernutrification or eutrophication (Beveridge 1996; Gowen and Bradbury 1987).

However, oxygen depletion and eutrophication may not be the most harmful effect of nutrient-stimulated phytoplankton and algal growth in offshore waters. High nutrient concentrations or imbalances in macronutrient ratios may promote shifts in phytoplankton community composition and, in some cases, result in the formation of blooms of toxin-producing dinoflagellates (Holligan, 1985). Blooms of toxin-producing dinoflagellates are called "red tides", but are more properly referred to as harmful algal blooms (HABs). These blooms can originate inshore or offshore, depending on the species and the locale. Harmful dinoflagellate blooms produced by between 20-70 toxic species, are very similar to blooms of non-toxic species and likely occur by competitive exclusion.

Nutrient loads from coastal aquaculture farms may contribute to the growth of these blooms (Folke *et al*., 1994); laboratory studies of fish-farm wastes indicate that they can stimulate dinoflagellate growth (Nishimura 1982). Similarly, biotin (vitamin B7), an additive commonly found in fish food and therefore in low levels in farm wastes, has been shown to enhance toxin production in marine dinoflagellates (Graneli et al. 1993). Blooms of certain of these species, such as *Chattonella marina* or *Gonyaulax catenella,* can produce biological toxins that kill other organisms. Neurotoxins produced by several algal species (e.g. *Alexandirum cantenella Gambierdiscus toxicus)* can be concentrated in filter-feeding bivalves such as mussels and oysters, creating a health risk to people consuming contaminated shellfish (viz. paralytic shellfish poisoning, ciguatera, and other shellfish poisonings; Bricelj and Shumway, 1998).

The dinoflagellate *Lingulolidium polyedrum* (formerly *Gonyaulax polyhedral*) is a neretic (nearshore or coastal shelf) species that has caused noticeable blooms in southern California waters since 1995. A bloom of *L. polyedra* was the primary cause of persistent red tides present in the project region during 2001 and 2005 (City of San Diego 2002-2007). Smaller blooms have also occurred in the intervening years. Gregorio and Pieper (2000) have found that this species persists at the Los Angeles River mouth from winter through summer and that river runoff during the rainy season provides significant amounts of nutrients that allow for rapid population increases.

Toxins associated with this species normally cause diarrhea in humans, with most cases traced to the consumption of contaminated shellfish. Likewise, toxins in the *Alexandrium catenella* dinoflagellate causes paralytic shellfish poisoning (PSP). This algae often originates in open coastal waters, and only then moves into bays and estuaries (Langlois, 2001). For example, *A. catenella*, was observed at sampling stations between Santa Barbara and San Diego counties during April 2008 (Langlois 2008). The relative abundance of *A. catenella* was highest at sites in San Diego counties. Low concentrations of PSP toxins continued to be detected in mussels at a number of sites between Santa Barbara and San Diego counties throughout April 2008. Finally, several species of *Pseudo-nitzschia* are responsible for domoic acid poisoning (amnesic shellfish poisoning). Severe domoic acid poisoning results in neurological damage, including death and affects humans as well as a wide range of marine wildlife. During April 2008, *Pseudo-nitzschia* was detected at numerous sites between San Luis Obispo and San Diego counties. The highest relative abundance of this species was observed offshore of the Palos Verdes peninsula; however, the highest concentration of domoic acid was 12 ppm in a mussel sample from southern Ventura County.

In addition to human health risks, several algae species are known to specifically impact fish, which could have an adverse effect on the viability of the proposed project. For example, the spines of some diatoms, like *Chaetoceros concavicornis* and its relatives, can irritate the gills of fish, causing mucous production and blood hypoxia that can lead to death (Rensel 1993,Yang and Albright, 1994). These diatoms of the subgenus Phaeoceros are ubiquitous in the North Pacific and some other oceans but rarely occur in large concentrations. "Blooms" of these diatoms rarely if ever occur at salmon farms but rather have been shown to be large-scale occurrences that kill fish at very low algal cell concentrations (Rensel 1995 and Anderson et al. 2001).

Similarly ubiquitous, *Heterosigma akashiwo* is a microflagellate known to form occasional large blooms on both sides of the North Pacific Ocean. These blooms result in large-scale fish kills, although the exact mechanism of mortality has not been discovered. Although this species has been observed off California, it is not known to bloom in large proportions here, at least in Monterey Bay and approaches (pers. comm. R. Marin III to J. Rensel at PICES 2007 HAB meeting, Victoria B.C.). Rather *Heterosigma* causes extensive fish kills about once or twice every ten years in Puget Sound, Washington. *Heterosigma* blooms are strongly associated with peak runoff from major rivers, and once initiated, are then advected through fish farming areas by winds and currents (Rensel 2007a, Anderson et al. in press). Similar blooms documented in Korea are also associated with reduced salinity events, however, no fish mortality has been observed there (Kim 2007).

In Baja California significant losses of tuna have occurred due to a dinoflagellate, *Gymnodinium* sp. (possibly *mikimotoi*). The exact species is not known as these dinoflagellates do not have a solid theca (outer shell), complicating identification. Another dinoflagellate, *Karenia brevis,* forms offshore blooms in portions of the Gulf of Mexico. When winds occasionally drive these blooms onshore along the west coast of Florida they have resulted in fish kills. Although the Southern California Bight occasionally experiences blooms of dinoflagellates such as those discussed above, the widespread occurrence of fish killing HABs has not been observed.

At temperatures <15 °C, however, it takes one to two days for an algal cell to divide, even if all of its photosynthetic needs are met. An algal bloom may result in cell densities increasing from a few thousand cells/ml to perhaps a million cells/ml. That requires eight or nine cell divisions and a minimum of 8 to 16 days. Phytoplankton in that water column will move up to 48 km during the eight days it takes to create a bloom. Statistically significant DIN concentrations have not been observed at a distance of 30.1 meters downcurrent from salmon farms and, therefore, it is considered very unlikely that nutrients released from aquaculture facilities would have any effect on phytoplankton production, unless they were released into an enclosed tank. Taylor and Horner (1994), Taylor (1993), Pridmore and Rutherford (1992), Banse *et al.* (1990) and Parsons *et al.* (1990) examined phytoplankton production and blooms of noxious phytoplankton in the Pacific Northwest. They concluded that nitrogen levels and phytoplankton production at salmon farms are determined by ambient conditions, and that salmon farms have little or no effect on ambient levels of either nutrients or phytoplankton density. The available literature is consistent with the previous general discussion and strongly supports a thesis that nutrients released from the RCF-SAP are not likely to initiate nor exacerbate HABs.

Bacteria can be an additional pollutant that is released by aquaculture. Some fish pathogens, such as *Streptococcus* bacteria, can infect humans who handle diseased fish. However, the offshore, open-ocean location of the proposed project is not amenable to most water-contact sports. Consequently, impacts to human health from bacterial water-quality degradation are likely to be minimal.

Calderwood *et al.* (1988) examined kidney, liver, spleen, heart and muscle tissues in wild and cultured salmon for the presence of viruses and 16 bacterial species, including several that are known human pathogens (*Vibrio vulnificus, Bacillus sp., Chromobacterium violaceum, Acinetobacter calcoaceticus, Vibrio sp., Aeromonas hydrophila* and *Streptococcus*). In every case, the prevalence of bacteria in cultured chinook salmon (*Oncorhynchus tshawytscha*) was much lower than in wild salmon. *Streptococcus sp.* were isolated from eight wild coho (*Oncorhynchus kisutch*) from the Chehalis hatchery whereas this species was absent in 150 cultured chinook from a Sooke Basin salmon farm. In summary, the available evidence suggests that the RCF-SAP would pose minimal risk of disease to either wild fish or to humans.

As shown in Figure 4.1-9, nutrient levels (particularly nitrogen and phosphorus) increase with increasing depth. Below the photic zone, these nutrients are naturally high, but phytoplankton growth at these greater depths is limited by the lack of ambient light. Similarly, nutrients generated by the net pens will be largely introduced at depth (~20 m) and excess feed and fecal material and will quickly pass below the photic zone and dissolve in transit to the seafloor.

Finally, discharge of aquaculture wastes may increase water column turbidity resulting from suspended particulates of excess feed and fecal matter. For example, the water-quality objectives of the California Ocean Plan limit allowable reductions in ambient light, and identify aesthetic water-quality standards relating to floating particulates and visible discoloration. These concerns are associated with turbidity within the upper ocean where it may be visible from the sea surface or limit the penetration of natural light within the photic zone. The bottom of the net pens will extend 12 to 15 m below the sea surface, which will minimize the reduction of ambient light from the presence of additional particulates within the photic zone.

Impact No. 2. Deposition of excess feed, fecal matter, and fish excretions may adversely impact seafloor sediments.

The most commonly reported and measurable effects of net pen aquaculture involve the near field excessive loading of bottom sediments with particulate organic matter. This was observed in many of the first net pen projects studied in North America in the 1970s (e.g., Pease 1974). By the 1980s, awareness of this problem resulted in improved siting selection, away from locations in shallow, poorly flushed bays and into more active channels and passages with strong currents (Parametrix 1990; Normandeau Associates and Battelle 2003). The state of Washington was at the forefront of recognizing and addressing impacts from excessive benthic deposition at net-pen facilities, and soon established siting guidelines for depth, current velocity, and nutrient loading. Over a period of 10 years from 1995 to 2005, annual monitoring of water and sediment quality for each net pen set in the state was conducted and resulted in the first NPDES discharge permits and sediment impact zones for net pen aquaculture in the U.S. (Rensel 2001).

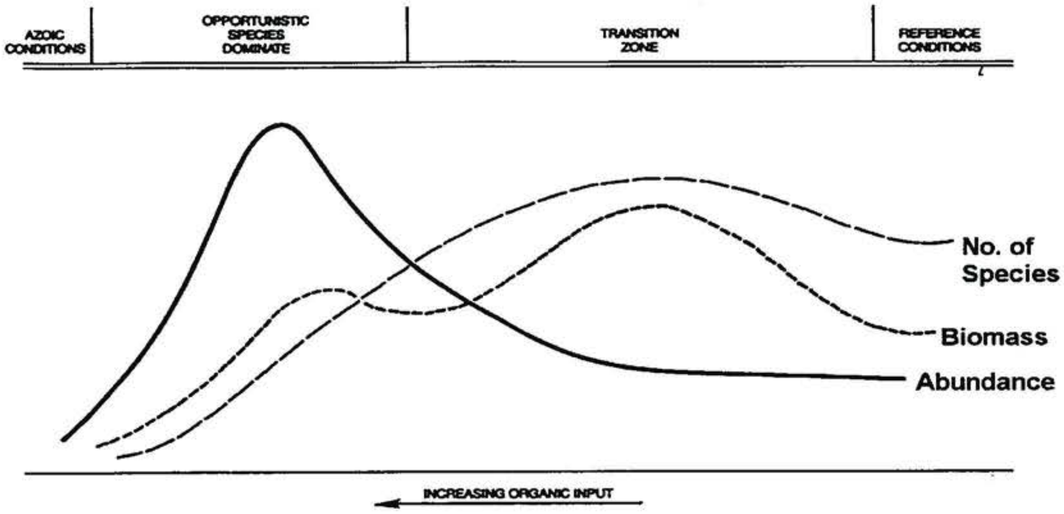
Nevertheless, studies have repeatedly implicated excessive feed as a cause of changes in benthic community structure around aquaculture facilities (Ritz *et al.*, 1989; Stenton-Dozey *et al.*, 1999; and Chamberlain and Stucchi 2007). It is an accepted fact that seafloor accumulations of unconsumed feed and fecal waste can result in organic buildup that produces a variety of physical, chemical, and biological changes within the benthos. Feed is broadcast onto the sea surface within net pens, and is consumed by the fish as it settles through the water column. When advanced feeding strategies and techniques are not used, a portion of the feed can reach the seafloor where it is entrained in benthic sediments and decomposed by microorganisms.

The primary effect of the increased organic carbon content is to increase in biological respiration and biomass. At appropriately low rates, such increases may even be beneficial, resulting in increased biomass and diversity of infauna, as shown in Figure 4.1-12 (Pearson and Rosenberg 1978). AquaModel computer simulation based on ADCP data collected from December 2007-March 2008 at a location 2 km to the northwest of the proposed project site indicates that only very light loading of organic carbon would occur because of strong currents throughout the water column, relatively great depth, and variability of current direction not experienced in nearshore, tidally-influenced net pen sites (Kiefer et al. 2008).

However, if nutrient loading is sufficiently high, the available rate of oxygen diffusion into the sediments is insufficient, and anaerobic bacteria will replace aerobic bacteria. This tends to reduce the diversity of benthic infauna as a result of sulfide and methane production levels that many invertebrates and fish cannot tolerate (Findlay and Watling 1995).

High nutrient loads within sediments below cage farms and downstream from raceways in freshwater and enclosed bays can result in low levels of biodiversity consisting largely of pollution-tolerant species (Beveridge, 1996). The increased food supply initially favors certain organisms over others. For example, in sediments depleted of oxygen by microbial decomposition, resident sedentary animals will die off, however, mobile populations of opportunistic species will migrate into the area. Therefore, although biomass and species diversity beneath the fish farm may increase, the community structure may alter substantially. Pollution tolerant species will begin to dominate, and eventually biomass and diversity will both decrease. Subsequently, mats of sulfide oxidizing bacteria called Beggiatoa will begin to form, indicating that decomposition of organics deposited under the net pens has become anaerobic.

Figure 4.1-12. Organic Input Effects on Benthic Infauna Composition



Source: Pearson and Rosenberg 1978

Benthic impacts have been also seen below and around marine-cage systems located in more-open coastal marine environments. However, the magnitude of change and the size of the affected benthic area vary with the speed of the current and other factors, such as water depth. The observed organic enrichment was typically localized within a relatively small area beneath and around the aquaculture facility (Gowen and Bradbury, 1987). For example, a study of a salmon farm in Maine showed that the farms had little impact on benthic ecosystems except within 20 meters of the net pen (Findlay and Watling, 1995). In contrast, a study of a salmon farm in the more-sheltered waters of Puget Sound exhibited benthic impacts up to 150 meters away from the net pens (Weston, 1990). After fish farms are removed, benthic ecosystems appear to recover over a period of a few months to several years (Johannssen *et al.*, 1994; Brooks *et al.* 2003).

Benthic effects should be anticipated with the culture or natural aggregation of any large biomass of animals. Brooks (2001) found that sediment enrichment occurred out to distances of 150 to 200 meters downcurrent from seven aquaculture farms in British Columbia that each produced 1,200 to 1,500 MT of Atlantic salmon during 24-month production cycles. Sedimented wastes from net pens are thought to occur above the resuspension threshold of about 9.5 cm/s for Atlantic salmon, although most other species have lower thresholds (Cromey et al. 2002a, 2002b).

Changes in sediment chemistry associated with organic enrichment at these seven farms included significantly increased concentrations of total volatile solids (TVS); increases in sediment concentrations of free sulfide ($S^{=}$, HS^- and H_2S); and reduced sediment redox potential. Brooks

(2001) is the first report documenting a clear, predictable, statistical relationship between these physicochemical endpoints (TVS, sulfides and redox) and biological endpoints.

Benthic infauna was affected by even small changes in these parameters up to distances of up to 225 meters downcurrent from the net pen perimeter. For example, opportunistic species and megafauna tended to proliferate at sites characterized by deep water and fast currents, while depauperate conditions were found under net pens located in the poorly flushed areas, irrespective of the water's depth. Water depths at the British Columbia farms ranged between 32.7 and 56.0 m. Mean surface (15 meters depth) current speeds were 3.40 to 8.30 cm/sec and maximum speeds were 25 to 50 cm/sec.

For comparison, the RCF-SAP is located in 80 meters of water where mean monthly surface current speeds in the alongshore direction appear to generally exceed 6 cm/s (SIO 2008). However, it should also be noted that peak cultured biomass at the salmon farms investigated by Brooks (2001) was typically 1,100 to 2,250 MT per 24-month cycle. This works out to approximately one third of the proposed tonnage of the RCF-SAP, which aims to produce up to 5,000 MT of yellowtail jack or other local species annually.

Goyette and Brooks (1999) and Brooks (2001) have shown significant changes in the composition of benthic macrofauna associated with small changes in sedimented labile organic matter (<0.5 % TVS). Therefore, it should be expected that even though solid waste discharged from net pens at the RCF-SAP will be dispersed over large distances and that accumulations in local sediments should be small, there may still be observable changes recorded in the benthic invertebrate community. A major goal of proposed project should be to describe organic loading to sediments near the RCF-SAP facility and to document the resulting changes in sediment physicochemistry and the macrofaunal community. This will likely be the most significant, if not the only significant, effect on the local environment. However, it should be noted that the expected significant dispersal of farm waste at this site could result in large increases in the abundance of benthic macrofauna with only small reductions in biodiversity. Under any circumstances, these effects will likely be short-lived and the literature suggests conditions will revert to baseline levels within a matter of a few months of fallow.

Many of the above studies were conducted around aquaculture facilities located in shallow-water coastal regions where currents are generally weaker on average than those expected at the proposed project's deep-water location. However, current velocities and alongshore directional flow are highly variable within the project area, in addition to being subject to substantial seasonal variations. The emission of organic particulates from the proposed project will have a perceptible impact on benthic sediments, particularly if subsurface current velocities drop below the deposition thresholds for fish feces (3.0 cm/s) and for waste feed (4.5 cm/s) (Kiefer et al 2008) for any substantial length of time.

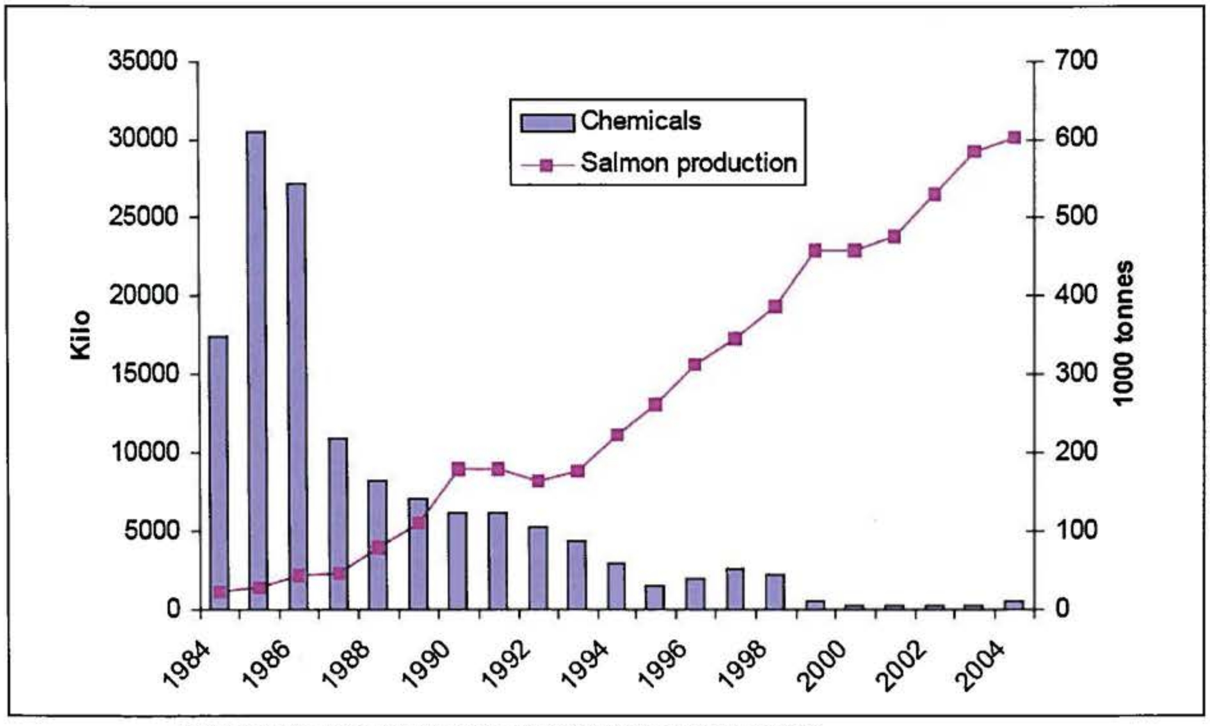
Impact No. 3. Antibiotics and other therapeutic chemicals released into the marine environment may adversely affect water and sediment quality.

Several varieties of chemicals may be applied in aquaculture operations. These include: a) antibiotics to treat or control disease; b) pesticides to control weeds, algae, and parasites; c) hormones to initiate spawning; d) anesthetics to transport and handle fish; and e) pigments, vitamins, and minerals to promote rapid growth with desired qualities. Aquaculture chemicals are usually placed directly into seawater within a contained area where dilution can be slowed while still treating the fish. Regardless, this procedure can potentially affect water quality and marine organisms.

As of 1991, roughly 50 antibacterial drugs were being used in aquaculture worldwide (Bjorkland, 1991). The large number of chemicals being used in aquaculture worldwide triggered concern about the ecological and human-health impacts of these chemicals. However, very few antibiotics or other drugs are approved for aquaculture use in the U.S. because the process of obtaining formal approval for new drugs is considered expensive and time-consuming (NRC, 1992; OTA, 1995) and as discussed below, use of efficacious vaccines have obviated the need for antibiotics in all but a few isolated cases. In addition, many drugs used in fish farms have been found to have minimal deleterious effects on the aquatic environment (Costelloe *et al.*, 1998). In fact, the use of antibiotics, therapeutants and antifoulants at marine fish farms has declined greatly (up to 95%) in the last 20 years, resulting in decreased potential for secondary harmful effects of these chemicals on the marine environment (Price and Morris 2013).

Antibiotics. Antibiotic use by commercial marine fish farmers in most areas worldwide has declined exponentially since the late 1980s and early 1990s (see Figure 4.1-13) due to improvements in fish husbandry, implementation of best management practices, and the use of newly-developed vaccines that are far more effective and economical than use of antibiotics (Price and Morris 2013). In fact, by 1995 vaccines against common salmon diseases had reduced antibiotics use to two percent of its usage levels throughout the late 1980's and early 1990's (Kontali 1996).

Figure 4.1-13. Use of chemicals in the Norwegian salmon farming industry versus fish production, 1980-2004



Source: The Norwegian Medicinal Depot, cited in Asche and Tveterås 2005

While the RCF-SAP does not include salmon in its suite of cultured species, the environmental response to the intensive culture of the three proposed species is likely similar to that of salmon. Nash *et al.* (2001) concluded that the impact on non-target organisms by the use of therapeutic compounds (both pharmaceuticals and pesticides) at net-pen farms was an issue requiring careful management to avoid potential adverse effects. Three antibiotics are registered in the U.S. for use in aquaculture (oxytetracycline, sulfadimethoxine plus ormetoprim (i.e. Romet-30), and Sulfamerazine). Sulfamerazine is licensed for aquaculture use but is no longer marketed, while Oxytetracycline can only be used within the limits of an aquaculture Investigational New Animal Drug (INAD).

Antibiotics are applied to fish using baths, injections, and oral treatments. Oral administration through the incorporation of drugs in feed is the most common method (Smith, 1991). Antibiotics thus may enter the marine environment after leaching from uneaten feed and feces. Antibiotics applied as feed are often not fully consumed due to palatability issues with the feed, reduced appetites in ailing fish, and limited intestinal absorption (Roed, 1991). Instead, most antibiotics applied to aquaculture systems end up bound to particles in the sediment (Pillay 1992). Antibiotics and other therapeutic chemicals added to feed can also affect organisms for which they were not intended when the drugs are released into the water column as the uneaten pellets decompose (Grant and Briggs, 1998; Provost *et al.*, 1997, Price and Morris 2013). Additionally, although the persistence of antibiotics in sediments varies, synthetic antibiotics, such as quinolones, may remain in the environment for long periods because they are not easily broken down by microbes.

The potential for use of antibiotics for the proposed project is unknown at this time, but is expected to be minimal. Instead, the program will rely on vaccines as they become available and the implementation of best management practices to prevent disease and quickly isolate and remove individuals who become diseased. However, in the event that significant quantities of antibiotics are anticipated to be used, a provisional monitoring plan should be initiated to determine residue levels in local fauna – particularly mussels and decapods. Prior studies have shown no detectable concentrations of antibiotics (Terramycin) in mussels held within salmon cages for 10 days of continual treatment (Tibbs). Regulators of the two largest producers of salmon on the Pacific Coast of North America (British Columbia and Washington State) do not currently require routine monitoring for antibiotic effects or residues, however, they retain the right to require such monitoring should antibiotic use increase substantially in response to new epizootics.

Feed additives - zinc. Zinc is an essential mineral important for insulin structure and function in vertebrates, and as a co-factor of carbonic anhydrase. It is added to salmon feeds in trace amounts equal to 30 to 100 mg/g (Chow and Schell, 1978). Elevated zinc concentrations (up to 1,500 µg Zn/g dry sediment) have been observed in sediments at some British Columbia salmon farms. This is significantly higher than any of the available benchmarks, which range from 197.5 µg Zn/g (mean of the TEL and PEL) to 270 µg Zn/g (Washington State Marine Sediment Quality Criterion). In the state of Washington, however, no fish farm has ever exceeded the state's sediment standards of 410 mg/kg (maximum concentration). This "corresponds to a sediment quality that will result in no adverse effects, including no acute or chronic adverse effects on biological resources and no significant health risk to humans" (Washington Administrative Code 173-204).

Recently, studies at eight fish farms in the state of Washington found a mean concentration of zinc at 30 m distance from the farms in the predominant current direction of 68.0 mg/kg (dry weight of sediment) with a standard deviation of 45.6 (N = 120, 5 replicates per station). The concentrations ranged from below what is normally found to slightly higher but were biased upwards by a single sample that may have included some waste zinc from galvanizing wastes (Rensel 2007a). Historically, zinc supplements have relied on zinc sulfate, which has been added to feeds in excess because of its low bioavailability.

Following recognition of this problem, however, feed manufacturers began supplementing salmon feeds with a zinc-methionine analog or with a proteinated form. Brooks (2000d) reported the results of a sediment zinc study at British Columbia salmon farms. Mean (± 95% CI) zinc concentrations at five reference stations was 30.7 ± 21.3 μg Zn/g. Mean zinc concentrations at farms using the zinc methionine formulation were 30.6 ± 14.7 μg Zn/g and sediment zinc concentrations at one farm remaining on zinc sulfate supplementation was 178.2 ± 87.3 μg/g. It should be noted that all of the elevated zinc concentrations were found in association with high sulfide concentrations, which rendered the metal non-toxic (see Di Toro *et al.* 1992). It should also be noted that Brooks (2000a) found that sedimented zinc at the Moonbeam farm in British Columbia declined during chemical remediation and was found at background concentrations when sediment chemical remediation was complete (i.e. when TVS and sulfides returned to background concentrations). While changing the form of zinc supplementation has ameliorated the problem, it has not completely solved it and Brooks (2001) continued to document sporadically elevated zinc concentrations in sediments near British Columbia salmon farms. Therefore, further monitoring of this metal is recommended.

Parasiticides. A number of parasiticides are approved to control sea lice in farmed salmon outside the U.S. (Nash *et al.* 2001). Only formalin is approved at present for farmed salmon. However, *Cypermethrin* (dichlorvos) has a temporary registration in the U.S. as an investigative drug for sea lice control. There are a number of other investigative drugs used in British Columbia and Europe to control sea lice under the direct supervision of a veterinarian (*Ivermectin, Emamectin benzoate Calicide,Slice™ and etc.*). There is no current evidence suggesting that sea lice will be a problem in the project area for the species being proposed for culture and no use of therapeutics for sea lice control is anticipated for the proposed project.

Overall, potential water-quality impacts from the limited used of therapeutic chemicals are not likely to be significant. The applicant does not anticipate the use of any chemicals for this project because of the siting and proposed management practices that are planned. However, if needed in an unexpected epizootic, the applicant will use only a limited number of chemicals, sparingly, and in low concentrations. As an example, hydrogen peroxide (H_2O_2) will be diluted prior to discharge so that it will rapidly disassociate in seawater.

4.1.5.2 Mitigation Measures

The three impacts to marine water and sediment quality described above are not likely to be significant, with or without application of the mitigation measures described here. However, one of the stated goals of the proposed project is to systematically address environmental concerns associated with offshore aquaculture operations. Another is to develop baseline and operational environmental data to support national standards for aquaculture effluent guidelines. To achieve these goals, the proposed project may implement monitoring and management programs that exceed requirements stated in any future NPDES discharge permit or that may be needed to meet aquaculture effluent limitations that the EPA may develop in the future. The applicant will work with EPA to develop and implement a series of best management practices that are specific to the project as well as being applicable to net-pen aquaculture in general. The following mitigation measures will not only help to reduce impacts from the proposed project but also help to achieve the stated goals of the project.

Impact No. 1. Organic particulates discharged during aquaculture activities may locally degrade marine water quality.

Mitigation Measure. Conduct a receiving-water monitoring program capable of delineating the extent of the discharge plume emanating from the net pens.

Receiving-water monitoring can mitigate potential water quality impacts from the proposed project by identifying the extent of any water quality perturbations or discharge problems early, so appropriate actions can be taken before the impacts become significant. For example, if measured concentrations exceed the receiving-water objectives of the California Ocean Plan (SWRCB, 2012), aquaculture production levels will be curtailed until additional source-reduction measures can be implemented or until increased receiving-water dispersion can be attained that demonstrate compliance. Implementation of some of the monitoring components described below will increase the likelihood that these goals will be achieved.

Water properties can be measured around the net pens to determine their mixing zone and region of influence. Dye-diffusion studies can be conducted to ascertain initial dilution rates and calibrate dispersion models. Dispersion rates and diffusivity can be measured with paired drogue releases. Continuously measured parameters may include: temperature, salinity, depth, pH, water clarity, dissolved oxygen, and fluorescence to determine chlorophyll levels or dye concentrations in a diffusion study. Analyses of discrete water samples may include salinity, ammonia, nitrate/nitrite, total nitrogen, total dissolved solids, total organic carbon, total phosphorous, and total suspended solids, metals, pesticides, pathogens, antibiotics and other drugs utilized by the operation.

Baseline water-quality data could be collected from proposed net-pen sites prior to installation to augment data available from existing monitoring stations (PLOO and CalCofi sites) in the area. This site-specific data could be used to assess the assimilative capacity of the receiving waters for oxygen depletion (BOD) and nutrient (nitrogen and phosphorus) utilization. After installation, monthly water-quality surveys could be conducted around the net pens and the net-pen point-source discharge.

Subsequently, the sampling frequency could be reviewed for reduction to a quarterly basis if no significant water-quality impacts were observed following two years of operation at peak production levels. Preferably, spatial sampling resolution should be sufficient to delineate the effluent plume so that dispersion models can be adequately calibrated using contemporaneous measurements of flow-velocity profiles.

Impact No. 2. Deposition of excess feed, fecal matter, and fish excretions may adversely impact seafloor sediments.

Mitigation Measure. Conduct a benthic impact assessment capable of detecting project-related changes to seafloor chemistry and benthic infaunal communities. If significant adverse effects on benthic quality are observed (as defined below), abatement measures will be instituted to reduce impacts to benthic sediments and communities.

With careful implementation, the applicant's proposed benthic-monitoring program, described in Section 2.6, will serve as an adequate sentinel for unacceptable benthic impacts. This plan is subject to review and approval the EPA as part of the NPDES permit process. For example, the benthic impact assessment can be based on a rigorous statistical design that includes before-after-control-impact (BACI) sampling (Green 1979). The foundation of BACI impact assessments is collection of baseline data before the impacts occur, namely before the aquaculture facility is brought online.

Another often-ignored component of a rigorous sampling design is statistical power analysis. Acceptable detection levels and error rates should be established before the sampling program is designed. The statistical significance of perceived impacts to the benthos and the power to detect them determine the sampling effort. Sampling effort should be established by equating the two types of error rates. The Type-I error rate, as measured by α, reflects the probability of falsely finding an impact when in fact, there was none. The Type-II error rate, as measured by β, reflects the probability of not finding an impact that exists. Equating these error rates in impact assessments spreads the risk equally between environmental and sustainable-development concerns (Skalski, 1995). In the highly variable benthic environment, relatively high error rates of α=0.2 are often required to produce tractable sampling designs.

Sampling will include benthic infauna and epifauna as well as sediment chemistry and grain size at a series of stations centered along the project's anticipated depositional trajectory path. Bulk sediment chemistry analyses will include: moisture, total volatile solids, total nitrogen (TN), total organic carbon (TOC), phosphate, and hydrogen sulfide.

There is ample evidence indicating that changes to the benthos are frequently associated with aquaculture operations, particularly net pens. These real effects require a detailed physicochemical monitoring program to include sediment TVS, redox potential, free sulfides, nitrogen and phosphorus, copper and zinc on at least a quarterly basis. Additionally, the macrofaunal community should be described in detail once each season for the first production cycle or first two years (i.e. eight sampling events). Once the most impacted (dominantly downcurrent) transect is identified, consideration should be given to reducing macrofaunal sampling on the other three transects at each treatment site and evaluating infauna at multiple stations along the impacted transect. This will eliminate unneeded sampling and increase resolution of the regression approach on the most impacted transect. Following that characterization and the confirmation of the predictability of changes in macrofauna based on physicochemical surrogates (see Brooks 2001), macrofaunal monitoring can be significantly reduced or eliminated unless/until significant changes in the operation are proposed.

Mitigation Measure. Model the nutrient (both dissolved and particulate wastes) dispersion around the net pens.

Unless the lack of significant adverse impacts on benthic quality can be projected based on the initial scaled approach (1000 to 1500 MT), any anticipated expansion of aquaculture production will be postponed. Hydrodynamic models can successfully predict the dispersion of wastes generated by aquaculture facilities. They are particularly useful when calibrated by field measurements, such as dye-diffusion studies and a benthic-monitoring program as described in the previous mitigation measures. The model will require detailed hydrographic and bathymetric data as well as information concerning fish farm practices such as the production tonnage and the food conversion ratio. To meet these modeling requirements, flow measurements will be collected at a nearby current-meter mooring, preferably one capable of recording a vertical velocity profile throughout the water column. The resulting model can also be used to optimize the spacing between net pens so that benthic impact footprints do not overlap.

The phased approach to conducting the proposed project and the associated data collection will also allow the revision and re-calibration of the two simulation models (AquaModel and DEPOMOD) that will be applied to the proposed project. By taking such iterative steps and using site-specific data, acquired above, any environmental response from future expansion to the project can be more accurately predicted.

Mitigation Measure. Identify and implement all practicable net pen management practices to reduce excess nutrient discharges to the marine environment.

EPA has determined that there are no known technologies currently available that are feasible for the collection of net-pen wastes (USEPA 2000; USEPA 2004). This finding is similar to what the Washington Department of Ecology determined in 1996 for the first NPDES net pen permits in the nation. Consequently, effective mitigation involves prevention techniques and technologies that minimize the generation of the wastes within the net pens themselves; namely, by applying feeding techniques that limit the loss of unconsumed food and food fines. The ideal approach to reducing marine impacts from the introduction of pollutants is to prevent or reduce the production of pollutants in the first place. Source reduction technologies and practices in aquaculture can minimize the production of nutrient and synthetic chemical pollutants. Less preferable approaches involve recycling, treatment, or disposal of wastes in the environment.

Careful attention to cage layout is one way to reduce the impact of contaminants. For example, the applicant plans to orient the cages perpendicular to the prevailing current, in two mooring grids of two rows each. The applicant also plans to carefully monitor population densities within the cages to both optimize feed conversion and growth performance efficiencies as well as to minimize the release of uneaten feed and limit the localized accumulation of fish wastes. Generally, more intensive (densely stocked) aquaculture systems result in increases in acute impacts to marine waters through the production of larger quantities of polluting wastes within a confined area. Similarly, avoiding overly dense siting of the net pens will further limit problems from increased waste accumulation due to overlapping impact areas.

Pollution from unconsumed aquaculture feeds can also be reduced both in the manufacture of aquaculture feeds and through good feed-management practices. Feed formulations can be adjusted to reduce the release of excess nutrients into the marine environment. Historically, aquatic animal feeds were specially formulated to ensure economically optimal growth, whereas, now they are also increasingly being formulated to minimize environmental impacts. These advances have resulted in the manufacture of feeds that are both high in energy and nutrient-dense. This has resulted in improved feed conversion efficiencies with less waste discharge.

Over the past two decades, with improvements in fish feeds, feeding techniques and understanding of feeding behavior, the percentage of feed waste produced for dry feeds has decreased to 1% to 5% (Beveridge 1996; Beveridge and Kadri 2000). The applicant intends to rely entirely on dry pellet food distributed to the net pens manually as well as via mechanical feeders (air or water-based transport through pipes).

Nutrient pollution from fish feed will be reduced by good feed management practices that include:

- Reducing overfeeding by feeding small amounts of feed relatively often, (depending on fish size, water temperature, current velocity and ambient dissolved oxygen concentration.
- Optimizing feed delivery based on feed consumption under different temperatures, fish size, fish species, flow velocities, temperature, and other conditions.
- Utilizing underwater cameras to evaluate real-time monitoring of pellet loss during feeding and adjust feeding strategies, feed rates, and total volume in order to minimize overfeeding.
- Use of feed rate prediction software that is often included as part of fish-farm management software.

Impact No. 3. Antibiotics and other therapeutic chemicals released into the marine environment may adversely affect water and sediment quality.

Mitigation Measure. Use of chemicals should be minimized by practicing preventive medicine, adopting biological controls, and adopting optimal/best aquaculture management practices.

An Integrated Pest Management approach, which decreases stress to the fish, employs stocking densities to keep fish healthy and uses preventative vaccination, can be used to maintain fish health while minimizing or eliminating the use of antibiotic drugs. The applicant plans to minimize the use of chemical by preventing aquaculture pests from becoming a problem in the first place and, if pests become problematic, adopting biological rather than chemical controls where possible. For example, in some cases wrasse are stocked with salmon to help control sea lice infestations (Price and Morris 2013). When vaccines become available for the project species, fish will be vaccinated prior to stocking them into the net pens, minimizing or eliminating the need for antibiotic use. Practicing preventive medicine, such as stocking fish free of pathogens and parasites, minimizing physical stresses on fish, and vaccinating fish against disease will reduce the need for remedial measures involving chemical applications. Fish are stressed by poor water quality, high stocking rates, human handling of fish, and unnatural physical conditions (Hastein 1995). Eliminating the use of drugs, pesticides, and other chemicals in aquaculture systems may also give producers the advantage of marketing organic products that can be sold for higher prices than non-organic products.

The applicant has been at the forefront of fisheries research and enhancement for decades. The applicant is eminently qualified to develop viable aquaculture management techniques that minimize environmental impacts through advanced husbandry of marine organisms. Testing of these techniques during this demonstration project will lead to reductions in the use of aquaculture drugs through the development of preventative-medicine practices that will:

- Minimize the exposure of fish to pathogens,
- Further the development of vaccines to immunize fish for specific diseases,
- Identify disease-free fish at early life stages, and
- Eliminate stressors that make fish susceptible to disease.

Significant use of therapeutics at this site is not anticipated. However, a plan for environmental monitoring, developed in accordance with the EPA should be developed and implemented if, or when, some threshold level of therapeutic use is exceeded. Such a plan might involve the collection of water samples at 15 meters depth adjacent to the pen and at a distance of 35 m downcurrent plus the collection of crustaceans from the bottom in the immediate vicinity of the net pen for analysis of tissue residues of therapeutics (if they are present). In addition, *Mytilus edulis galloprovincialis* should be collected from the perimeter of the net pen receiving treatment, and their tissues analyzed periodically during treatment for therapeutic residue. These *in-situ* bioassays have proven valuable for assessing a variety of environmental affects (see Goyette and Brooks, 1999).

4.2 Marine Biological Resources

4.2.6 Environmental Setting

The Southern California Bight is characterized by complex current circulation patterns, a diverse range of marine habitats, and is home to a wide variety of marine flora and fauna. The mainland coast of the SCB consists of rocky shores, sandy beaches, and embayments of different types, while offshore islands provide additional habitat, serving as valuable breeding grounds for marine birds and mammals. Since the offshore islands are situated some distance from a heavily populated coastline in southern California, they often represent the best examples of pristine environments in the SCB. Distributed between the mainland and the offshore islands are a series of submarine canyons, ridges, and basins, that provide some of the most unique marine habitats in the SCB. Descriptions of the marine flora and fauna that reside in the proposed project area in the Bight follow below. Much of the data is derived from several long term monitoring programs within the region, particularly the Point Loma wastewater treatment plant's Ocean Outfall monitoring program (City of San Diego 2007)

4.2.6.1 Plankton

The term 'plankton' refers to organisms that have limited or no swimming ability and drift or float along with ocean currents. The two broad categories of plankton are phytoplankton and zooplankton. Phytoplankton, or plant plankton, form the base of the food web by photosynthesizing organic matter from water, carbon dioxide, and light. They are usually unicellular or colonial algae and provide forage for zooplankton, fish, and, through their eventual decay, large quantities of marine bacteria. In contrast, zooplankton are essentially microscopic animal plankton. They act as a primary link between phytoplankton and larger marine organisms in most marine food webs.

Several important terms are used to further differentiate planktonic forms based on their life histories. Holoplankton are those organisms that spend their entire life as plankton, while meroplankton spend only a portion of their life cycle as plankton. For example, the larval stages of benthic invertebrates frequently fall into the category of meroplankton; they lead a planktonic existence until they mature, at which time they settle into to the bottom of the ocean to take up their adult life. Ichthyoplankton are a specialized category of zooplankton, comprised of the larval stages of fish. Many of the fishes and invertebrates that are important to the commercial and recreational fisheries in the SCB, including sea urchins, rockfish, and most crustaceans, spend the early stages of their lives among the plankton.

Plankton distribution, abundance, and productivity within the SCB are dependent on several environmental factors, including light availability, nutrients, water quality, terrestrial runoff, upwelling, and small-scale eddy activity (see Section 4.1 Marine Water Quality Resources). As a result, plankton distribution within the SCB tends to be very patchy and characterized by high seasonal and inter-annual variability. Because phytoplankton are photosynthetic, they are generally limited to the photic zone, whereas zooplankton can occur throughout the water column from surface to bottom.

Phytoplankton

Standard measures for describing phytoplankton communities are productivity, standing crop, and species composition. Data from several studies (e.g., Bolin and Abbott, 1963; Allen, 1945) indicate that the phytoplankton community is similar in species composition along the entire coast of California, and consists primarily of diatoms, dinoflagellates, silicoflagellates, and coccolithophores (BLM 1979). The diatom *Chaetoceros* was the most abundant species found along the entire coast (Bolin and Abbott, 1963; Cupp, 1943). Other dominant species included the diatoms *Skeletonema, Nitzschia, Eucampia, Thalassionema, Rhizo-solenia* and *Asterionella,* and the dinoflagellates *Ceratium, Peridinium, Noctiluca,* and *Gonyaulax* (Bolin and Abbott, 1963).

Reid et al. (1978) found a similar population structure when he studied the vertical distribution of plankton assemblages in the nearshore part of the SCB during March 1976. Out of the fifty-eight samples collected from between La Jolla and Santa Monica Bay, the 20 most abundant species collected during this survey are listed in Table 4.2.1. They closely follow the previous studies' findings; however, the most abundant species within the chlorophyll maximum layer in this region were the dinoflagellate *Exuviella* sp. and the ciliate *Mesodinium rubrum.*

Table 4.2.1. Top 20 Most Abundant Phytoplankton Species Found off Southern California

1.	*Exuviaella* sp.	*dinoflagellate*
2.	*Scrippsiella* sp./*Peridinium trochoideum* (Stein) Lemm.	*dinoflagellate*
3.	*Skeletonema costatum* (Greve.) Cleve	*diatom*
4.	*Eucampia zodiacus* Ehrenberg	*diatom*
5.	*Prorocentrum gracile* Schutt	*dinoflagellate*
6.	*Calciosolenia murrayi* Schlauder	*coccolithophore*
7.	*Thalassiothrix frauenfeldii* (Grun.) Grunow	*diatom*
8.	*Gymnodinium* sp. A	*dinoflagellate*
9.	*Gymnodinium splendens* Lebour	*dinoflagellate*
10.	*Mesodinium rubrum* Lohmann	*ciliate*
11.	*Rhizosolenia fragilissima* Bergon (small form)	*diatom*
12.	*Eutreptiella gymnastica* Throndsen	*euglenophyte*
13.	*Hemiaulus sinensis* Grev.	*diatom*
14.	*Ceratium kofoidii* Jorgensen	*dinoflagellate*
15.	*Torodinium robustum* Kofoid and Swezy	*dinoflagellate*
16.	*Gymnodinium* sp. S	*dinoflagellate*
17.	*Leptocylindrus danicus* Cleve	*diatom*
18.	*Cochlodinium catenatum* Okamura	*dinoflagellate*
19.	*Peridinium minutum* Kofoid	*dinoflagellate*
20.	*Gonyaulax polyedra* Stein	*dinoflagellate*

Source: Reid et al., 1978

Zooplankton

Zooplankton are those animals that spend part (meroplankton) or all (holoplankton) of their life cycle as plankton. Zooplankton are often further categorized by size, i.e., their tendency to pass through (microzooplankton) or be retained (macrozooplankton) by a typical-sized plankton net of (250-300um) (Dawson and Pieper, 1993). The temporal and spatial distributions of plankton are dependent on a number of factors including currents, water temperature, and phytoplankton abundance (Loeb et al., 1983). Spring blooms occur for both meroplankton and holoplankton while fall blooms tend to be restricted to the holoplankton. The meroplankton include the larvae of many commercial species of fish, lobster, and crabs. Like phytoplankton, spatial distribution of zooplankton is extremely patchy. However, a number of studies have established the importance of the nearshore ecosystem to the early development of fish.

Based on data collected by the California Cooperative Oceanic Fisheries Investigations (CalCOFI), McGowan and Miller (1980) and Venrick (1993) reported a high degree of variability in species composition in offshore waters and that dominant species vary widely even from sample to sample. Kramer and Smith (1972), estimated that 546 invertebrate and 1,000 species of fish larvae occur in the California Current System. Major zooplankton groups off the California coast include copepods, euphausiids, chaetognaths, mollusks, thaliaceans, and fish larvae. The ichthyoplankton component here is comprised mostly of northern anchovy (*Engraulis mordax*), Pacific whiting (*Merluccius productus*), and rockfishes (Sebastes spp.).

Roesler and Chelton (1987) concluded that zooplankton abundance in the southern area of the SCB was controlled by local biomass response to changes in the advective environment. In microzooplankton studies conducted off La Jolla, Beers and Stewart (1970) determined that biomass tends to decrease from onshore to offshore. Protozoans account for the greatest percentage of microzooplankton numerically, while the micrometazoans dominate when calculating by biomass (Beers and Stewart 1970). Beers and Stewart also found that protozoans, dominated by ciliates, accounted for 23-32% of the microzooplankton biomass, while copepod nauplii accounted for approximately 60% of the total metazoan organic carbon.

Seasonal studies at Diablo Canyon, off the central California coast, indicate that zooplankton production is highest during the spring and summer months, coincidental with upwelling periods where nutrient rich waters are driven to the sea surface by prevailing winds (Icanberry and Warrick, 1978; Smith, 1974). Within most areas of the Bight, spring densities are approximately five times greater than the summer densities, and approximately ten times greater than winter densities. Phytoplankton productivity also tends to be higher near the coastline than farther out near the islands; enrichment of nearshore waters by runoff and sewage discharges has been positively associated with increases in phytoplankton productivity.

Major El Niño events also have an extensive effect on zooplankton populations (Chelton et al. 1982). Anomalies in zooplankton abundance, water temperature and salinity, and southward transport in the California Current are highly correlated across years. Increases in southward transport (La Niña events) are associated with increases in zooplankton production, colder temperatures, and lower salinity, whereas decreases in the southward transport (El Niño events) result in unusually low zooplankton biomass, warmer temperatures, and higher salinity.

Likewise, small-scale (<50 km diameter) cyclonic eddies are now recognized as common features having a substantial influence on primary production and plankton transport within the SCB, particularly in the Santa Barbara Channel and Santa Monica-San Pedro Basin regions. Most (75%) of these eddies are under 10 km in diameter and relatively short-lived (days to weeks). In a typical eddy, relatively narrow (i.e. several kilometers wide) bands or patches of higher chlorophyll-a concentrations are associated with a colder, and probably nutrient-enriched, tongue of water originating offshore that circulates in a counter-clockwise motion, gradually moving westward. The introduction of colder, nutrient-rich waters from deeper depths to the surface in the eddy's core region further stimulates plankton growth.

4.2.6.2 Benthos

Benthic habitats are generally classified according to substrate type. Benthic habitats consisting of unconsolidated sediments (e.g., gravel, sand, or mud) are referred to as soft bottom and habitats consisting of rock are generally referred to as hard bottom or rocky substrate. Both soft and hard-bottom habitats support distinctive types of biological communities. For example, epifaunal benthic organisms are attached or motile species that inhabit rock or sediment surfaces, while infaunal benthic organisms live in rock or within soft sediments (Thompson et al. 1993). Generally, more is known about intertidal and shallow subtidal benthic species (<30 m) than those of deeper areas (>30 m).

In the general project area, the benthic habitat consists largely of deep sediments overlying a gently westerly (280°) sloping bottom. The seafloor within the region is generally smooth and featureless (soft-bottom substrate) except for occasional, low-relief outcrops of sedimentary rock. These hard-bottom areas are interspersed with soft substrate, and are mainly of base rock and rocky outcrops that may be covered with a thin veneer of sediments (Thompson et al. 1993).

The occasional low-relief rock outcrop is often populated by filter-feeding species such as cup corals and anemones for whom such structures provide a means of support and increased contact with detritus carried on ocean currents and by marine snow. Elsewhere in the Bight, offshore oil platforms or pipelines also occasionally interrupt the smooth sedimentary environment with localized relief, acting as important, if artificial, nurseries and shelters for rockfish and many other key marine species.

Bottom-profiling surveys of the area surrounding the RCF-SAP site suggest that much of the immediate area consists of soft-bottom substrate, and that the nearest hard substrate features are located more than 1,600 m from the project site. Benthic assemblages on the coastal shelf off San Diego, where the RCF-SAP site is located, typically vary with sediment particle size and/or along depth gradients. Grain size generally decreases with increasing distance from shore, changing from medium sands to silts and clays, which in turn provide different habitat advantages to the various benthic species that inhabit them. In addition to substrate type and water depth, temperature, distance from shore, food availability, and water quality are also important factors that influence the distribution of benthic organisms.

During 2013, semiannual surveys (January and July) of ocean sediments collected at twenty-two sites (see Figure 4.1-9) around the PLOO found that sediments in the region are predominantly composed of fine sands and fine particles (silt and clay) (Table 4.1.3). At the two stations nearest the RCF-SAP site, fine sediments (clay and silt fractions) averaged from slightly over 50% at Station E26 to approximately 71% fines at Station B8. Station E26, is the closest station to the proposed RCF-SAP site in terms of distance (1.6 km) but is located nearly 20m deeper (98 m) than the proposed site, while Station B8 is located slightly further away (2.3 km), but along a shallower depth contour (88m) (Table 4.1.3).

The sediment characteristics displayed at the various locations near the project site are considered typical of the mid- continental shelf, and are thought to reflect the multiple origins of sediments in the region. These data suggesting that the area is not subject to fast moving currents or large disturbances (e.g., storm surge, rapid suspension/deposition of materials. This quiescent environment supports a suite of infaunal organisms that is heavily dominated by polychaete worms (52%). Crustaceans also make up a substantial portion of the infaunal abundance (25%), while echinoderms comprised 8%. Molluscs and all other taxa combined each contributed ≤8%.

Polychaete worms were not only the most abundant, but also the most diverse taxa collected during the 2013 benthic field surveys, comprising up to 54% of the species collected. Crustaceans and molluscs comprised 23% and 13% of the species respectively, while echinoderms and all other taxa combined each contributed ≤6% of the species. The ophiuroid *Amphioida urtica* was the most abundant species overall, accounting for approximately 7% of all benthic invertebrates collected, and occurring in 98% of grabs. Of the 10 most abundant species, however, the most widely distributed were the polychaetes *Prionospio jubata* and *Chaetozone hartmanae*, both of which occurred in 100% of the samples collected. Similarly, assemblages of trawl-caught invertebrates in 2013 were dominated by the sea urchin *Lytechinus pictus*, which occurred in all trawls and accounted for 81% of the total invertebrate abundance.

Along and above the seafloor, small flatfishes typically constitute the majority of the demersal fish population in the area (City of San Diego 2014). In particular, the Pacific sanddab has been the numerically dominant species in the region since the PLOO sampling program began in 1991. This species was captured in every trawl conducted in 2013 and constituted 57% of all fishes caught. Other commonly captured, but less abundant species, include bigmouth sole, California lizardfish, California skate, Dover sole, English sole, halfbanded rockfish, hornyhead turbot, longspine combfish, Pacific argentine, pink seaperch, plainfin midshipman, shortspine combfish, and stripetail rockfish. Most fishes collected by trawl in 2013 were < 21 cm in length.

A cluster analysis of macrofaunal assemblages at the PLOO primary core stations sampled during 2013 revealed that the benthic assemblage found at Station E26, the benthic monitoring station located closest to the RCF-SAP site, was comparable to that defining background conditions for the PLOO monitoring region described over the past several years (City of San Diego 2010–2013) and is considered characteristic of 100-meter mid-shelf depths in the Southern California Bight. The most abundant taxa characterizing the assemblage included the ostracods *Euphilomedes producta* and *E. carcharodonta*, the polychaete *Chloeia pinnata*, the spionid polychaete *Prionospio jubata*, the cirratulid polychaete *Chaetozone hartmanae*, and the ophiuroid *Amphiodia urtica*. Species richness at this site was 79 species per 0.1 m^2, while abundance averaged 265 individuals per grab (City of San Diego 2014). The species richness at Station B8 was slightly lower, at 66 species per 0.1 m^2, while abundance at that site averaged 213 individuals per grab.

4.2.6.3 Fishes

Pelagic fishes are those species that occur in the water column. Dominant epipelagic fishes in the SCB include planktivorous schooling fishes such as the northern anchovy and Pacific mackerel (*Scomber japonicus*); predatory schooling fishes such as Pacific bonito (*Sarda chiliensis*) and yellowtail (*Seriola lalandi*); and by large, predatory fishes such as blue shark (*Prionace glauca*) and swordfish (*Xiphias gladius*) (Cross and Allen 1993).

Northern anchovy, Pacific sardine (*Sardinops sagax*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel, and Pacific whiting are resident species whose reproductive cycles are adapted to flow characteristics in the SCB. Northern anchovy is the most abundant epipelagic fish and is usually the dominant species throughout the year. From spring through fall, the SCB can be inhabited by Pacific saury (*Cololabis saira*), bluefin tuna (*Thunnus thynnus*), yellowtail jack, and many large, solitary predators that emigrate from tropical and oceanic areas (Cross and Allen 1993). Several of these species are fished by commercial and recreational fishers in the SCB.

Demersal fish species are those associated with the ocean bottom. Soft substrates are the predominant benthic habitat in the project area. Approximately 40% of the species in southern California occur on soft substrates along the open coast. This includes 126 species that occur on the mainland shelf and 47 species occur on the mainland slope (Cross and Allen 1993). Common species include the Pacific sanddab (*Citharichthys sordidus*), slender sole (*Lyopsetta exilis*), white croaker (*Genyonemus lineatus*), spiny dogfish (*Squalus acanthias*), and several species of rockfishes. Depending on species, benthic fish feed on both pelagic and benthic prey in the project area (Allen 1982).

Just to the south of the proposed project area, otter trawls are performed along the 100 m isobath as part of the long-term monitoring program around the Point Loma wastewater treatment plant's ocean outfall. Some of the most common trawl-caught fishes include Pacific sanddab, longfin sanddab, Dover sole, hornyhead turbot, California tonguefish, plainfin midshipman, and yellowchin sculpin. Pacific sanddabs generally dominate the catch. Invertebrates including the urchins *Lytechinus pictus* and *Allocentrotus fragilis*, and the sea stars *Luidia foliata* and *Astropecten verrilli* are also commonly encountered in these trawls (City of San Diego 2008-2014).

Commercial and recreational fishing activities, including kelp harvesting, also occur at various locations within the project area. A wide variety of finfish and shellfish species are harvested in the region, while kelp is harvested in specific beds that are managed by the California Department of Fish and Wildlife (CDFW). An analysis of fishery data collected from the proposed project area for the six-year period from 2006 to 2011 is contained in Section 4.3, Commercial and Recreational Fisheries.

4.2.6.4 Marine Mammals

Thirty-four marine mammal species have been recorded in the waters off southern California (Tables 4.2.2 – 4.2.4). They include more than 30 species of cetaceans (whales, dolphins, and porpoises), six species of pinnipeds (seals and sea lions), and the southern sea otter. All marine mammals are protected under the provisions of the Marine Mammal Protection Act (MMPA) and the California Fish and Game Code. Endangered and threatened marine mammals are further protected under the Endangered Species Act (ESA). Additionally, under the MMPA, a species or population stock that is below its optimum sustainable population may be considered 'depleted', while a marine mammal stock that is already listed under the ESA, is declining and likely to be listed, or exhibits a level of direct human-caused mortality that exceeds the potential biological removal level may be considered as 'strategic'.

Table 4.2.2. Federally Threatened, Endangered, and Protected Mysticetes (Baleen Whales)

Species	**Occurrence in the SCB**	**Protected Status**
California gray whale ***Eschrichtius robustus***	Common in season, December - May	MMPA
Humpback whale ***Megaptera novaeangliae***	Common in season, late May - November	Endangered; strategic, depleted MMPA
Blue whale ***Balaenoptera musculus***	Common in season, June - November	Endangered; strategic, depleted MMPA
Fin whale ***Balaenoptera physalus***	Common at specific offshore sites, summer and early fall	Endangered; strategic, depleted MMPA
Minke whale ***Balaenoptera acutorostrata***	Uncommon	MMPA
Bryde's whale ***Balaenoptera edeni***	Rare	MMPA
Sei whale ***Balaenoptera borealis***	Rare	Endangered; strategic, depleted MMPA
North Pacific right whale ***Eubalaena japonica***	Extremely rare	Endangered; strategic, depleted MMPA

Table 4.2.3. Federally Threatened, Endangered, and Protected Odontocetes (Toothed Whales, Dolphins and Porpoises)

Species	Occurrence in the SCB	Protected Status
Sperm whale ***Macrocephalus physeter***	Uncommon; April – June, August to November	Endangered; strategic, depleted MMPA
Baird's beaked whale ***Berardius bairdii***	Rare; late spring to early fall	MMPA
Dwarf sperm whale ***Kogia simus***	Rare	MMPA
Pygmy sperm whale ***Kogia breviceps***	Rare	MMPA
Beaked whales: Hubbs' beaked whale ***Mesoplodon carlhubbsi*** Blainville's beaked whale ***Mesoplodon densirostris*** Ginkgo-toothed whale ***Mesoplodon ginkgodens*** Perrin's beaked whale ***Mesoplodon perrini*** Stejneger's beaked whale ***Mesoplodon stejnegeri***	Rare	MMPA
Dall's porpoise ***Phocoenoides dalli***	Rare; winter and early spring	MMPA
Harbor porpoise ***Phocoena phocoena***	Rare; fall and winter	MMPA
Cuvier's beaked whale ***Ziphius cavirostris***	Extremely rare; year-round	MMPA
Long-beaked common dolphin ***Delphinus capensis***	Common; year-round, more in summer and fall	MMPA
Short-beaked common dolphin ***Delphinus delphis***	Common; year-round, more in late fall to spring	MMPA
Short-finned pilot whale ***Globicephala macrorhynchus***	Rare; year-round (historically)	MMPA
Risso's dolphin ***Grampus griseus***	Common; year-round	MMPA
Pacific white-sided dolphin ***Lagenorhynchus obliquidens***	Common; late spring and summer	MMPA
Northern right whale dolphin ***Lissodelphis borealis***	Uncommon; late spring and summer	MMPA
Killer whale ***Orcinus orca***	Uncommon	MMPA
False killer whale ***Pseudorca crassidens***	Rare; summer and early fall	MMPA
Spotted dolphin ***Stenella attenuata***	Rare; summer and early fall	MMPA
Striped dolphin ***Stenella coeruleoalba***	Rare; summer and early fall	MMPA
Long-snouted spinner dolphin ***Stenella longirostri***	Rare; summer and early fall	MMPA
Rough-toothed dolphin ***Steno bredanensis***	Rare; summer and early fall	MMPA

Table 4.2.3. Federally Threatened, Endangered, and Protected Odontocetes (Toothed Whales, Dolphins and Porpoises)

Species	Occurrence in the SCB	Protected Status
Bottlenose dolphin ***Tursiops truncatus***	Common	MMPA

Sources: Carretta et al. 2006; Angliss et al. 2005

Table 4.2.4. Federally Threatened, Endangered, and Protected Pinnipeds and the Southern Sea Otter

Species	Occurrence in the SCB	Protected Status
California sea lion ***Zalophus californianus***	Year-round resident, breeds on several Channel Islands and the mainland coast	MMPA
Harbor seal ***Phoca vitulina***	Year-round resident, breeds on several Channel Islands and the mainland coast	MMPA
Northern fur seal ***Callorhinus ursinus***	Year-round resident, breeds on San Miguel Island	MMPA
Northern elephant seal ***Mirounga angustirostris***	Year-round resident, breeds on several Channel Islands and the mainland coast	MMPA
Northern (Stellar) sea lion ***Eumetopias jubatus***	Rare visitor	MMPA
Guadalupe fur seal ***Arctocephalus townsendi***	Seasonal visitor to the Channel Islands, main breeding population at Isla de Guadalupe, Mexico	Threatened; strategic, depleted MMPA
Southern sea otter ***Enhydra lutris nereis***	Year-round resident with peak in numbers within the northern SCB in spring	Threatened; strategic, depleted MMPA

Sources: Carretta et al. 2006; Angliss et al. 2005; USFWS 2003; Howorth 1995 and 1998.

Cetaceans occur in the project area year-round, although the species present may vary from season to season or from year to year. In particular, seven odontocete species represent the major cetacean fauna found off of south-central California. They are the Pacific white-sided dolphin (*Lagenorhynchus* obliquidens), the northern right whale dolphin (*Lissodelphis borealis*), Risso's dolphin (*Grampus griseus*), Dall's porpoise (*Phocoenoides dalli*), the harbor porpoise (*Phocoena phocoena*) and two species of common dolphin (*Delphinus delphis, D. capensis*). Cetacean population levels in the region are generally at their lowest in spring, and are at their highest levels during the fall (Dohl et al. 1983a).

Six species of pinnipeds are found offshore southern California (Table 4.2.3). Some of the species are year-round residents while others migrate in and out of the region each year. Major pinniped breeding grounds are found on the Channel Islands, well outside of the project area, while haul-out areas are located on both the mainland coast and on the Islands.

The nearest pinniped haul-out to the project site is located on the mainland coastline at Casa Beach in La Jolla, approximately 13 km (8 miles) from the project site. Approximately 200 harbor seals reside in this area year-round (Lowry et at., 2005). In February 1999 this beach was recognized as a natural harbor seal haulout and rookery site by the National Marine Fisheries Service. Most recently, on August 14, 2014 the California Coastal Commission voted unanimously to close Casa Beach (a.k.a. Children's Pool beach) to the public during the harbor seals' five-month pupping season, from December 15 through May 15 to provide better protection to the seals. Despite occasional long-distance movements in excess of 200km, harbor seals oceans rarely forage more than 50km away from haul-out sites (Huber et al., 2001).

The southern sea otter (*Enhydra lutris nereis*) is another marine mammal with the potential to occur in the project area. Sea otters are classified as threatened under the ESA, depleted under the MMPA, and as a "fully protected mammal" under California state law. Southern sea otters off California feed almost entirely on macroinvertebrates such as abalone, crab, and sea urchin. However, in certain areas, they have been reported to feed on fish (Ebert 1968; Estes et al. 1981).

In California, otters live in waters less than 65 feet (20 m) deep and generally remain within a mile (1.6 km) of shore. Sea otters once ranged along shallow coastal waters from northern Japan across the Aleutians to Alaska, and down the west coast of Canada and the U.S. all the way to Baja California, Mexico. However, two hundred years ago, demand for the otter's pelt led to intensive hunting and the near extinction of the species. In fact, otters were thought to be extinct off California until the early 1900s, when a small remnant population of approximately 50 animals was discovered off Big Sur, in central California. This original population has since repopulated much of the California coast from Point Conception north (USFWS 2003).

The southern sea otter (*Enhydra lutris nereis*) population is currently estimated at approximately 2,944 individuals (USGS 2014). This figure includes a small subpopulation of just over 60 otters that resides in the waters around San Nicolas Island.

Although substantial changes have occurred in the distribution and density of sea otters within the California range in the last 20 years, these changes have generally been shifts in population distribution, and indicate increases in the use of some areas and declines in the use of others (Bonnell et al. 1983). Otters still primarily occur north of Point Conception; however, over the past two decades their range has begun to extend south of the Point and into southern California. As of the 2014 census, the southern range boundary is considered to be approximately 5 km west of Gaviota State Beach, while the northern boundary is considered to be approximately 2.5 km southeast of Pigeon Pt., in San Mateo County (USGS 2014).

To date, southern sea otters have not been seen in significant numbers as far south as the project area. However, occasional sightings of lone otters have occasionally occurred, and it is not unreasonable to assume that otters may continue to expand their range southward to encompass the Point Loma kelp beds and adjacent waters within the life of the proposed project.

4.2.6.5 Seabirds

The SCB is well known for its rich seabird population. The seabirds, along with sea ducks (scoters), loons, and western grebes, make up the greatest portion of the bird fauna that utilize the SCB (Table 4.2.5). Of the seabirds, the shearwaters, storm petrels, phalaropes, gulls, terns, and auklets are the most abundant species (Baird 1993). The SCB is a major foraging and resting area for both resident and migratory seabirds.

Table 4.2.5. Principal Seabird Species of the Southern California Bight

Species	Population Size
Pacific loon ***Gavia pacifica***	40,000–46,000
Western and Clark's grebes ***Aechmophorus occidentalis***	27,000
Surf scoter ***Melanitta perspicillata***	125,000
Pink-footed shearwater ***Puffinus creatopus***	40,000–400,000
Sooty shearwater ***Puffinus griseus***	2.7–4.7 million
Black-vented shearwater ***Puffinus opisthomelas***	20,000–30,000
Northern fulmar ***Fulmarus glacialis***	120,000–300,000
Leach's storm petrel* ***Oceanodroma leucorhoa***	150,000
Black storm petrel* ***Oceanodroma melania***	100,000
Least storm petrel* ***Halocyptena microsoma***	200,000
Brown pelican* ***Pelecanus occidentalis***	6,000–90,000
Red and red-necked phalarope ***Pharalopus fulicarius, P. lobatus***	925,000
Bonaparte's gull ***Larus philadelphia***	300,000
Heermann's gull ***Larus heermanni***	45,000
California gull ***Larus californicus***	5,000
Herring gull ***Larus argentatus***	32,500
Western gull* ***Larus occidentalis***	25,000–50,000
Black-legged kittiwake ***Rissa tridactyla***	50,000–300,000
Common and arctic tern ***Sterna hirundo, Sterna paradisaea***	30,000–50,000
Common murre ***Uria aalge***	20,000–30,000
Cassin's auklet* ***Ptychoramphus aleuticus***	50,000–100,000
Rhinoceros auklet* ***Cerorhinca monocerata***	100,000–300,000

Source: Adapted from Baird 1993
Notes: * indicates species which are known to breed on the Channel Islands.

Of the more than forty-three seabird species that utilize the waters of the SCB, approximately 22 species dominate (Table 4.2.5). Their use is year-round, with 17 of the species breeding locally (Baird 1993). All of the eight Channel Islands within the SCB are considered important seabird rookeries. The largest and most diverse rookery is located well to the north at San Miguel Island and Prince Island. However, Anacapa Island is also important because it is the primary place in California where the California brown pelican (*Pelicanus occidentalis*) breeds. This species suffered massive, population-wide reproductive failure in the 1960s and early 1970s as a result of DDT accumulation which led to severe eggshell thinning and other problems and its listing as an endangered species. When DDT was banned in the U.S. in 1972, the species started to slowly rebound. Today, more than 70,000 breeding pairs of pelicans inhabit California and Baja California. The success of the pelican's recovery resulted in its delisting as an endangered species in 2009.

Further south, tiny Santa Barbara Island shelters the largest breeding colony of the state threatened Scripps's murrelet (*Synthliboramphus scrippsi*). This robin-sized, seafaring bird nests on steep sea-slopes, canyons and cliffs and has a diet that includes larval fish and northern anchovy. Ten to 15 pairs of murrelet are known to nest on San Clemente Island, and additional nesting is also suspected on Catalina Island. Scripps's murrelets spend most of their lives at sea, and eat a variety of fish and small crustaceans. They only come ashore for nesting purposes, and are nocturnal in their nesting activities. A closely related species, the Guadalupe murrelet (*Synthliboramphus hypoleucus*) breeds on offshore islands in Mexico, but can also be found in the project area when it disperses northward after its breeding season.

Seabirds in the SCB most commonly eat fishes, squid, and crustaceans. Their methods of feeding provide a good indicator of their vulnerability to the proposed project. Diving species, in particular, can be vulnerable to nets that are located within the diving depth of feeding seabirds. Hence, diving species that occur in the SCB such as the Cassin's auklet, sooty shearwater, gulls, Pacific loons, western and Clark's grebes, Brandt's cormorants, scoters, and rhinoceros auklets can become entangled in the predator nets proposed facility should they be placed within the diving depths of these species. Albatrosses, brown pelicans, shearwaters, storm petrels, gulls, and terns feed in the upper few meters of the ocean surface while cormorants, loons, grebes, scoters, and alcids (auks) feed throughout the water column and may pursue their prey underwater for up to several meters (Baird 1993). These species, in particular, could be vulnerable to entanglement with the submerged portions of any predator nets.

4.2.6.6 Sea Turtles

Although uncommon, sea turtles are occasionally reported in the SCB. Sea turtles are circumglobal, occurring throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. Four species, all of which are protected under the Endangered Species Act, are known to occur in region, and could potentially appear at the project site. They are the green turtle, *Chelonia mydas*, the olive ridley turtle, *Lepidochelys olivacea*, the leatherback turtle, *Dermochelys coriacea*, and the loggerhead turtle, *Caretta caretta* (Table 4.2.6) (Hubbs 1977, NOAA 1998a-d). Olive ridley turtles are listed as a federally threatened species, while the populations of leatherback, loggerhead, and green turtles that occur off the southern California coast are listed as federally endangered species.

Table 4.2.6. Marine Turtles That May Occur in the Proposed Project Area

Species	Common Name	Protected Status
Chelonia mydas	Green turtle	Threatened, Breeding populations on Pacific coast of Mexico and in Florida are listed as Endangered
Lepidochelys olivacea	Olive ridley turtle	Threatened, Breeding populations in Mexico are listed as Endangered
Dermochelys coriacea	Leatherback turtle	Endangered
Caretta caretta	Loggerhead turtle	Endangered

Source: Adapted from Hubbs 1977.

All of the turtles that can occur in the project area are omnivorous, feeding on wide variety marine life including shellfish, jellyfish, squid, sea urchins, fish, and algae (Carr 1952; Mager 1984). All four species of turtles can dive to several hundred feet during feeding activities (Eckert 1993).

The leatherback is the most frequently encountered turtle off California, followed by the green, loggerhead, and olive ridley sea turtles (Stinson 1984); however, most leatherback sightings are concentrated north of Point Conception. Within the central and southern portions of the SCB, including the project area, green and loggerhead turtles are the most commonly encountered species. Marine turtles in the SCB generally occur in greatest abundance from July through September.

Along the Pacific coast loggerhead turtles range from the Gulf of Alaska southward, however, they are most frequently seen off the western Baja Peninsula. Nesting for this species occurs in the northern and southern temperate zones and subtropics, including parts of the southeastern coast of the U.S.

During El Niño periods, these sea turtles may range well north of their normal distributions, resulting in population increases offshore southern California. As a result of these population shifts, NOAA's National Marine Fisheries Service (NMFS) issued an interim final rule to protect loggerhead sea turtles that follow warmer El Niño currents into drift gillnet fishing areas of southern California at the turn of the century (USDOC 2002).

Olive ridley turtles are the smallest of the sea turtle species found in the eastern Pacific, and are similar enough to the loggerhead turtle in appearance that researchers and observers have historically had difficulty distinguishing the two species in the field. The breeding population origins and migratory habits of the olive ridley turtles frequenting waters off the west coast of the U.S. are unknown (NMFS and USFWS 1998). The primary threats to them while in U.S. waters appear to be incidental take in fisheries and boat collisions (or by U.S.-based fishing fleets).

In contrast to loggerhead and olive ridley turtles, leatherback sightings and strandings within the southern portions of the SCB near the project site are much rarer. Most sightings of these giant sea turtles occur in the northern portions of the Bight (off Santa Barbara County) and along the central California coast. DNA tracking of leatherbacks in Monterey Bay has demonstrated that most of the leatherbacks encountered off the California coast originate from nesting grounds in the western Pacific. These pelagic turtles undertake a trans-Pacific migration, appearing seasonally along the central and northern California coast where upwelling conditions generally provide a rich smorgasbord of their favorite food, jellyfish, during the fall.

The final, and most likely turtle species to be seen in the vicinity of the proposed RCF-SAP is the green sea turtle. There are two main green turtle breeding areas in the Northeast Pacific: Mexico (on the coast of Michoacan) and Hawaii (mainly at the French Frigate Shoals). Turtles in each region share similar patterns on their "plastron" (or lower shell) that can be used to trace their origin.

Green turtles are unique because their diet changes as they age. Juveniles are invertivores, feeding mainly on jellyfish and other invertebrates; however, as adults green turtles are exclusive herbivores, feeding on algae and sea grasses (Eckert 1993). It is thought that this diet imparts a greenish colour to their skin and fat, giving them their name.

As with loggerhead and olive ridleys, green turtles are normally a tropical species but occasionally may follow a warm current northward and end up in British Columbian or even Alaskan waters. Additionally, in the southern part of San Diego Bay the water is warmed by thermal effluent from the Duke Energy power plant, and supports a small population (~60 individuals) of green turtles, some of which are year-round residents, and others of which return to breeding grounds in Michoacan, Mexico, and the Islas Revillagigedo, a cluster of volcanic islands in the Pacific Ocean off Mexico. Until recently, the area near the Duke Energy power plant was the only area on the west coast of the U.S. where green turtles were known to aggregate (Stinson 1984); however, a second small colony has been identified in association with the thermal discharge from the Los Angeles Department of Water and Power's Haynes Generating Station to the San Gabriel River (Los Angeles Times 2008). In addition to turtles, the wide variety of fish and birds that inhabit South San Diego Bay (including a number of endangered species) led to the designation of 3,940 acres of wetlands, mudflats and eel grass beds in the South San Diego Bay as a National Wildlife Refuge by the U.S. Fish and Wildlife Service in 1999.

While marine turtles are not particularly common at sea in the immediate project area, strandings do occur locally on occasion (NOAA 1997 and 2007). Statewide, between 1995 and 2005, 134 strandings were reported to the California Sea Turtle Stranding Network operated by NOAA-fisheries (NOAA 2007). Of these, almost half (64) were green turtles, which are generally the most common marine turtle encountered off southern California. Incidental catch in fishing gear is a large problem for all sea turtles, as is injury from boat strikes. Additionally, many green sea turtles populations are now afflicted by a disease called fibropapillomatosis, which causes large tumors to grow on the head and face that can eventually interfere with feeding.

4.2.7 Project Impacts and Mitigation Measures

The sections that follow present the potential marine biological resources impacts and suggested mitigation measures associated with the proposed project.

4.2.7.1 Project Impacts

Impact No. 1. Benthic habitats would be disturbed or destroyed by the anchors and/or anchor chains that would be used to moor the fish cage grid and the support vessels.

A minimum of two anchors would be used to moor each of the 24 proposed fish cages to the seafloor within each of two mooring grids (see mooring diagram in Appendix II). Although the physical area the net pens will encompass at the sea surface is .24 km^2 x 2 grids, the anticipated anchoring grid footprint on the seafloor for the project is 1.62 km^2 x 2 grids. Additionally, an additional 80-100 foot vessel will remain on site to provide 24-hour security and assist in feeding and production activities at the net pens, while smaller supply vessels will visit the site on a daily basis to deliver personnel and other supplies. All vessels will be moored directly to the cage grid structure when on site, thereby avoiding impacts to substrate that could occur from repeated anchoring to the seafloor.

Bathymetric mapping of the seafloor beneath the project site indicates that there does not appear to be a hard substrate feature within 1,600 m (1 mile) of the site which would be threatened by the placing of the proposed 500 kg anchors. The furthest potential anchor locations required to maintain the cage grid in the required position are sited approximately 400 m (0.25 miles) from the cage grid perimeter. Although impacts to hard substrate features are not anticipated to occur from installation of the mooring grid and anchors, hard substrate is also often found underlying a thin veneer of soft bottom sediments. If hard substrate were to be encountered, impacts to such habitats and their associated benthic communities could be significant.

Surveys of hard-bottom structures have shown that these habitats are inhabited by a wide variety of benthic organisms. Ophiuroids, brachiopods, sponges, and echinoderms are common groups of invertebrates that occur on hard bottom substrates. Anemones, such as *Corynactis californica* and *Metridium senile,* and corals, such as *Lophelia californica,* may occur on higher relief structures in the project area. Hard-bottom structures also provide habitat for a variety of fish species that are subjected to considerable commercial and recreational fishing effort in the project region. This fishing effort is primarily focused on various rockfish species. Not only are hard-bottom habitats assumed to be ecologically sensitive, but they are also important for commercial and recreational purposes.

Anchor scars that were created in 1986 during the installation of the pipelines between Platforms Hermosa, Harvest, and Hidalgo were surveyed in 1992. Six years after disturbance, anchor scars were clearly visible in hard-bottom structures. Scars ranged from deep furrows in hard substrate to furrows created by the displacement of rocks (MRS, 1993). Furrows created by the anchors were typically 1-3 feet deep and up to 12 feet in width. Berms 0.5 to 1.5 feet high and consisting of sand or broken rock usually lined the scars that were surveyed. Comparison of biological communities in the scar and adjacent control areas showed that community parameters such as abundance and percent cover were significantly diminished in each of the anchor scars that were surveyed. Calculation of recovery rates for diminished species ranged from eight to 38 years depending on the location of the anchor scar. Although recolonization rates for deep water epifaunal organisms are not precisely known, the results from this study indicate that hard-bottom habitats, once damaged or disturbed, take many years to recover, if at all. Hence, anchors may permanently damage hard-bottom structures thereby reducing habitat for a wide variety of marine invertebrates and fish.

Although impacts to hard substrate features are not anticipated to occur with the project; unidentified hard substrate could be encountered while placing the anchors and chains for the mooring grid and cages. In soft substrates, displacement and some loss of benthic habitat and life may also occur; however, benthic infauna that reside in soft or sandy substrates tend to be fairly resilient to mechanical disturbance and any impact would be expected to be temporary in nature as recolonization would occur within a few weeks to months.

Impact No. 2. Wildlife may become entangled in the fish-pen nets mooring lines and other floating equipment or debris.

A wide variety of fish, marine mammals, and bird species are attracted to fish farming operations because they are a potential food source for those animals (GBC 1997, Price and Morris 2013). In particular, farmed fish are an attractant for seals, sea lions, predatory fish, and a variety of bird species. Uneaten fish food, fouling plants and animals that grow on nets and other equipment, and night lighting are also attractants for a variety of marine life (GBC 1997).

The primary concern with respect to these animals and marine cage culture tends to be the threat to the animals of entanglement with nets, mooring lines or other floating equipment (Price and Morris 2013). Entanglements can cause death to endangered or threatened seabirds, marine mammals, and sea turtles, to other marine mammals that are protected by the Marine Mammal Protection Act, and to other fish species.

Whale entanglements in commercial fishing gear off the U.S. west coast have been identified as an issue of concern by NOAA's National Marine Fisheries Service (NMFS) because of the potential impacts to both whales (individually and at a stock/population level) and the commercial fishing industry (Saez et al 2013). Whales entangled in gear may be injured and/or impaired which could affect the ability of individuals to survive and a population's ability to recover. Along the U.S. west coast, an average of 10 large whales were reported entangled in fishing gear between 2000 and 2012 (Saez et al 2013).

At marine fish farms, however, entanglement in the cage nets poses the biggest threat to sea birds, especially those that may dive to feed on fish or fouling organisms (Belle and Nash 2008). Although the number of seabird mortalities due to entanglement with fish-pen nets is not available, studies conducted in British Columbia indicate that great blue herons, kingfishers, and diving ducks were the most frequently reported species found tangled in various covering nets (Rueggeberg and Booth 1989). For diving birds, cormorants and mergansers were the most frequent species to die from drowning due to entanglement with fish-pen nets (Booth and Rueggeberg 1989; Krohn et al. 1995).

The Environmental Assessment Office, Government of British Columbia (EAO 1997), conducted an extensive review of salmon aquaculture practices and effects in the region. An important conclusion was that the location or placement of net-pen fish farms was an important criterion for avoiding conflicts with wildlife. Their recommendation was that fish-pen placement should be at least one kilometer away from locations having seal and sea lion rookeries, haul-out and wintering areas, and locations having marine bird colonies or concentrations (Iwama et al. 1997). The proposed project meets this recommendation since the facility is 4.5 km offshore. The nearest pinniped rookery is located at Casa Beach on the mainland shore in La Jolla, CA, which is approximately 12.9 km (8 miles) away from the proposed project site.

Negative interactions with wildlife can be further avoided or minimized with the use of rigid netting material for the cages, keeping mooring lines taut and removing any loose lines or floating equipment around the farm. Lines made of stiff materials will help prevent entanglements. Additionally, the proper disposal of all trash will reduce the risk that birds, sea turtles, or marine mammals will ingest plastic or other trash associated with farm operations (Price and Morris 2013).

Because of entanglement conflicts between certain types of commercial fishing nets and wildlife such as seabirds and marine mammals, net mesh sizes and locations where commercial fishing nets may be placed are regulated by the California Fish and Game Commission (CDFG 2001). Entangling nets (gill and trammel) used by the commercial fishing industry differ from fish farming nets in that they are designed to not be seen, and are hung loosely in order to capture target species. In contrast, fish farming nets are made of heavy, colored nylon that are designed to be highly visible, and are hung taut with weights to prevent entanglements and maximize fish rearing volume.

In general, the containment nets used in conjunction with traditional gravity design cages are designed to contain and grow fish while predator nets are designed to keep predators away from the containment nets. The containment nets for the proposed project would range in mesh size from 0.95 to 2.85 cm on the square (.37 to 1.1 inches on the square), depending on the size of the fish, and the predator nets will be 8 cm on the square (3.1 inches on the square), depending on the netting used. The smaller mesh size nets (containment nets) will be placed inside the bigger mesh size nets (predator nets). The nets will extend down from the sea surface to approximately 18 meters. Cover nets, or bird nets of 2.5-5 cm square mesh will also be stretched taut over the cage surface. These nets will be of a high visibility color and supported with floating net rings to prevent birds from weighing down the net to the water surface. Although these nets would not be used for fishing purposes, the small mesh sizes that are proposed for use may conflict with present fishing regulations, and pose an entanglement threat.

In contrast, newly developed, rigid net materials such as Kikko Net and copper netting, and cage systems such as the Aquapod or Seastation fish pens do not require a secondary anti-predation net. The semi-rigid structure of these cage systems results in the cages being both more durable and less likely to entangle wildlife.

NOAA-Fisheries published a List of Fisheries (LOF) for 2014 (79 FR 14418), as required by the Marine Mammal Protection Act (MMPA). The LOF for 2014 reflects the most recent information on interactions between commercial fisheries and marine mammals. NOAA-Fisheries must categorize each commercial fishery on the LOF into one of three categories under the MMPA based upon the level of serious injury and mortality of marine mammals that occurs incidental to each fishery. The categorization of a fishery in the LOF determines whether participants in that fishery are subject to certain provisions of the MMPA, such as registration, observer coverage, and take reduction plan requirements.

In 2006, NOAA-Fisheries added the nearby "California white seabass enhancement netpen fishery" (i.e., OREHP) to the LOF as a Category III fishery[2]. The status of this fishery remained unchanged in 2014. As originally noted by NOAA-Fisheries,

> *"...the fishery consists of a total of 13 enhancement net pens from Santa Barbara to San Diego, CA that are used as growout facilities for juvenile white seabass before release.. ...There have been two observed mortalities of the U.S. stock of California sea lions in this fishery. There are 13 participants in this fishery as each pen represents a participant."*

Further communication with staff at CDFW determined that there have actually been three California sea lion mortalities in the history of the program; one at the growout facility in Santa Barbara in 2004 and two at the Channel Islands Harbor[3] facility in 2005 (CDFW 2007). Given these mortality events, the potential impacts associated with the proposed project would be potentially significant in the absence of mitigation. However, implementation of the mitigation measures below would reduce or eliminate potential predator entanglement impacts to a ***less than significant*** level.

Impact No. 3. The deposition of excess fish food, fecal matter and fish excretions may potentially alter the benthic community in the proposed project area.

Over the past two decades, with improvements in fish feed, fish feeding techniques and understanding of fish feeding behavior, the percentage of feed waste produced from fish farms has been reduced from 15 to 20% to below 5% (Gowen et al. 1991, Findlay and Watling 1995, and Braaten et al. 1983, Beveridge 1996; Beveridge and Kadri, 2000, and Price and Morris 2013). For example, modern extruded fish feeds result in less waste than compacted pelleted feeds, while both are more efficient than using raw and unprocessed fish as feed. Feed buoyancy and sinking rates can vary somewhat; generally, moist feeds have greater buoyancy than dry feeds so fish have a longer time period to ingest pellets before they settle to the bottom. However, the greater buoyancy of moist feeds also provides more opportunity for pellets to drift out of the cages or to dissolve in the water column (Burd, 1997). The implementation of underwater video to monitor feeding activities has also helped reduce underwater waste levels further. Nevertheless, excess feed and feces remain the predominant sources of nutrient outflow from marine aquaculture operations and can lead to benthic impacts (Belle and Nash 2008).

During the initial phase of the proposed project, a maximum annual production of 1,000 to 1,500 metric tons (MT) of fish would be produced in the fish pens. This amount would increase to an annual maximum of 5,000 MT in following years, depending on the project's environmental compatibility. Huntington et al. (2006) calculated that salmonid and sea bass farms release between 31-62% of nitrogen and 11-34% of phosphorus in feed as soluble waste, and that an estimated 22 g of nitrogen and 9.5 g of phosphorus are produced as particulate waste per every 1000 g fish harvested.

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[2] Category III: Annual mortality and serious injury of a stock in a given fishery is less than or equal to 1 percent of the Potential Biological Removal (PBR) level.

[3] . It is likely that the mortalities at Channel Islands were due to moving the netpen temporarily closer to the bait barge so the dock could be repaired. This situation has since been corrected.

Although each species will vary, based on these estimates, and assuming that production for the first year achieves 1,000 MT, the proposed project will generate approximately 22 kg of nitrogen and 9.5 kg of phosphorus as waste. At peak production, the project could be generating as much as 110 kg of nitrogen and 47.5 kg of phosphorous to the marine environment per year. However, this figure does not account for excess food that the fish did not eat, nor for how much of the nutrients actually accumulate in the sediments. For example, Braaten (2007) reported that 19% of nitrogen and 50% of phosphorus in salmon feeds are ultimately deposited in the sediments below cages. Similarly, Strain and Hargrave (2005) estimate that 9 kg of nitrogen and 2.3 kg of phosphorus per ton of fish production accumulate in the sediment over a three year grow out cycle, with the highest levels occurring in the first and third years.

The water depth where the fish pens would be located is approximately 80 meters. At this depth, the fish feed and feces that are discharged will be dispersed over a wide area. Excess food and feces may settle and accumulate on the seafloor, or be consumed or respired by other animals and organisms before it ever reaches the seafloor. Studies have indicated that the excessive deposition of food and feces can cause changes in the benthic community structure whereby detritus feeders can replace sensitive filter-feeding organisms due to burial (Burd 1997; Stenton-Dozey et al. 1999). Sedentary animals may also die due to depleted oxygen levels resulting from the microbial decomposition of the waste material. Studies conducted beneath salmon pens in British Columbia indicate that large and sensitive macrofaunal and epifaunal species disappear first, followed by organic enrichment tolerant macrofauna, organic enrichment meiofauna, and finally, aerobic bacteria.

When the sediments become completely anoxic, the aerobic bacteria, meiofauna and macrofauna found in sediments are completely eliminated (Burd, 1997). However, deposition levels of below 1 gram per m^2 per day of carbon input to the benthos in temperate waters are not likely to result in adverse effects, and enrichment of the infauna community in terms of increased diversity and abundance is likely (Pearson and Rosenberg 1978; Chamberlain and Stucchi 2007; Hargrave et al. 2008).

The National Ocean Service, and Systems Science Applications, Inc. is preparing an updated version of the AquaModel simulation of the proposed project for RCF which will incorporate information on ambient ocean conditions at the project site and current speeds soon to be acquired during the deployment of a current meter system, as well as known fish physiology parameters approximating the target species (Kiefer et al 2008). AquaModel is a proprietary modeling program composed of interlinked submodels of fish physiology, hydrodynamics, water quality, solids dispersion, and assimilation that creates 3-dimensional simulations of parameters such as growth, and particulate waste flow. The previous modeling effort was based on a maximum load of 2700 MT. The results of the updated study will be based on a maximum load of 5,000 MT and be used to determine if organic carbon deposition and impact from the proposed project would be largely undetectable by chemical assays and if bottom currents are sufficiently strong to prevent consolidation of waste materials on the seafloor. In the case of particulate wastes, feces and uneaten food were estimated to sink to the seafloor at average rates of 3.2cm/s and 9.5 cm/s. Deposition thresholds (for particles that settled during low flow periods) were estimated to be 3.0 cm s^{-1} for fish feces and 4.5 cm s^{-1} for waste feed as explained in the report (Kiefer et al 2008).

The previous AquaModel simulations and report findings relied on current velocity and direction averages obtained from a single deployment of an acoustic Doppler current profiler (ADCP) between 14 December 2007 and 20 March 2008. During this timeframe, the mean current velocity varied throughout the water column, with direction also varying considerably but predominately favoring a southerly direction. Near the surface, the current averaged 21.6 cm/s, while just above the bottom it averaged 8.3 cm/s. The near-bottom average velocity was well in excess of the 4.5 cm/s deposition threshold used in the Aquamodel modeling and that velocity was exceeded 80% of the entire current meter record period for waste feed and 91% of the time for fish feces. However, the swift, predominately southerly current that was measured using the ADCP during the winter of 2007-2008 is not necessarily reflective of regional oceanic conditions during other seasons. During the summer months, particularly, the poleward Southern California Countercurrent generally dominates in flow regimes along the coast. Therefore, the ADCP will be redeployed at the proposed project site in October 2014 and remain in place for a longer duration.

A parallel modeling exercise will be conducted using DEPOMOD, a Scottish origin software program that has been used for 15 years to provide guidance for permitting marine cage operations around the globe (Cromey et al. 2002; Cromey and Black 2005; Cromey et al. 2012). DEPOMOD predicts organic carbon deposition and accumulation beneath fish farms and the model estimates impact on benthic invertebrate communities. Results from AquaModel and DEPOMOD simulations will: (1) demonstrate the value of modeling as a predictive tool for permitting and regulation; (2) guide siting, monitoring requirements, and best management practices for aquaculture operations, and (3) validate use of models as a proactive tool to provide stakeholders with high confidence in making space for aquaculture in the coastal ocean.

The flow direction of the near-bottom waters in the project area is predominately to the east, with a slight northerly component that is evident throughout much of the year. Near-bottom current information is important because the bulk of resuspended sediments may be confined to within 5 m of the sea floor, where near-bottom currents will govern dispersion and accumulation of such particles (Hendricks 1993). Mean bottom-current flow may periodically drop down near 6 cm/s. At these times, it is likely that fluctuations in flow rates result in flows also dropping below the 4.5 cm/s threshold for deposition, although these episodes do not appear to be long-lived.

A small percentage of the sedimented wastes will still be expected to "consolidate" on the bottom depending on the temporal extent of the slow velocity periods, but at this site those periods are expected to be relatively short for the available data. Therefore, it is expected that much of the deposited wastes will be resuspended, further dispersed and aerobically assimilated by the naturally occurring benthic organisms.

However, given that periods of slower bottom flow in the SIO ADCP record from 2006-2008 exist, and recognizing the presence of slight northward subthermocline flow concluded from the 1976 SCCWRP sampling, with a deposition threshold of 4.5 cm/s there could be potential impacts to the benthic environment from nutrient enrichment as a result of the project. Regardless, although the benthic community structure may change in the project area, any resulting impact will most likely be restricted to the areas beneath the net pens and are therefore considered to be insignificant. However, a benthic monitoring program shall be implemented during the project to ensure that benthic impacts do not occur over a wide area in the project vicinity. If widespread impacts to the benthos are observed, feeding strategies, fish densities, and project goals shall be revised to minimize the dispersal of waste from the project. Because the proposed project will implement a comprehensive benthic monitoring program, benthic impacts will be minimized to every extent possible and are considered to be insignificant.

Impact No. 4. Cultured fish may escape from containment, impacting the genetic integrity of wild populations.

Escapes are not in the economic interest of producers; however despite technological advances that have been made to net materials and other containment features, escapes can and do still occur. When they happen, the escapees may interact biologically with the wild population resulting in alterations to the population's genetic integrity or profile, the introduction of new or unusual genotypes, and potential erosion of their reproductive fitness, particularly if escapees are originally from non-local stock or selected by the breeders for certain farm traits (Nash et al 2005).

The most important and direct consequence of escaped fish on the wild population is through interbreeding. The effects of interbreeding are a reduction of genetic variance between the two populations, and out-breeding depression. There is evidence that farmed fish are capable of breeding with their conspecific natural populations in the wild (Nash et al 2005). Therefore escapees may present a genetic threat to locally adapted natural populations through intraspecific hybridization, resulting in a reduction in overall reproductive fitness and recruitment to the wild population. Some interspecific hybridization might also occur should farmed fish escape into an ecosystem where there are very closely related species (Nash et al 2005). The use of reproductively sterile farm fish has been proposed as one means of preventing genetic interactions with wild populations, but is not yet considered a viable alternative.

In addition to interbreeding, escaped fish may compete with wild populations for mates and nesting sites. They may compete with native species for forage and habitat space, predate on endemic fish populations, and act as vectors for the introduction of bacterial or viral pathogens or parasites (see Impact No. 5). The effects of these processes can be a reduction in the genetic integrity of a community or an ecosystem. In brief, the outcome can be a reduction in the numerical or genetic fitness of the wild population, and possibly a reduction in the fitness of other fish populations.

There are a number of ways for biological interactions to occur in an aquatic ecosystem where aquaculture activities are practiced. Farmed fish can escape directly from their enclosures due to human error, damage from a catastrophic natural event such as a severe storm, or following damage to the structure by predators. Additionally, some species of finfish and shellfish that spawn freely in captivity and produce pelagic eggs may release fertilized gametes into the surrounding environment. Finally, domestically cultured fish and shellfish raised in hatcheries can be released intentionally on a large scale in annual stock enhancement or sea-ranching programs, leaving them to migrate freely and interact with wild populations.

The chance of these interactions occurring is affected by a number of factors, the most important of which being opportunity. Escapees are rarely sexually mature, as they are harvested by commercial growers before nutritional energy is directed to the development of gonads. The few that might be selected as future broodstock at harvest time would be moved elsewhere, usually to a land based hatchery. Therefore, at the time of escape, escapees are not necessarily mature enough to breed. Secondly, the escapees might not last long enough to mature in the wild and interbreed. Thirdly, the timing of the escape might not be coincidental with the natural breeding season of the wild population. Catastrophic events may be large but they are also very rare, and chronic events may be continual but usually involve very few fish. Consequently, the timing of an escape, the numbers of escapees, and the size of the wild population are all variables which play a role in defining the opportunity for biological interaction (Nash et al 2005).

For most of the aquatic species commercially cultured in the U.S., the potential outcomes of these risks have neither occurred nor are anticipated to occur because:

- Producers have a strong economic incentive to prevent escape of cultured animals and to recover animals that do escape,
- Most pathogens are naturally occurring and ubiquitous,
- Most species are cultured in their native range,
- Successful introduction and spread of nonnative species often meets strong biological resistance, and
- Federal and state agencies have implemented a variety of invasive-species regulations to prevent, control, manage, or mitigate potential impacts (Tucker and Hargreaves, 2008).

Although a zero-escape threshold cannot be guaranteed, the implementation of a detailed management program consisting of best husbandry practices, including the thorough screening and selection of healthy, genetically robust hatchery stock, monitoring and maintenance of net pens and equipment, and monitoring of environmental conditions, shall be implemented. Although the proposed project cannot entirely prevent escapes from occurring, impacts will be minimized to every extent possible and are considered to be insignificant.

Impact No. 5. Pathogens or diseases associated with the cultured species may be transferred to wild fish stocks or to the fish community residing in the project area.

Pathogenic organisms and diseases are natural components of any ecosystem. Understanding the causes for disease outbreaks requires an understanding of the variables associated with the pathogens, the host, and the environment (Hedrick, 1998). Under culture conditions, the pathogens are often the best understood because their accessibility facilitates scientific scrutiny. Host variables, on the other hand, are often poorly understood. These include the animal's genetic susceptibility to disease as well as its immune and nutritional status. Environmental variables include the physical, biological, and chemical characteristics of the animal's surroundings, such as water temperature and presence or absence of natural or anthropogenic toxins. Health assessment and screening of animals prior to and during their placement in the pens, proper site selection for enclosures and adhering to 'best practices' of animal husbandry are commonly-employed methods of maintaining the health of farmed or cultured species, including fish.

As is the case for any wildlife/livestock interface, the potential exists for disease transfer between cultured and wild fish. Pathogens may be present in the water column or food supply (whether inherently or through introduction), or may be transmitted by direct contact with a disease vector, such as another infected fish. Disease prevention through control of variables such as host quality and environment is essential and would include careful selection and screening of fish and proper siting of the net pens. Cultured animals would be rigorously screened by a CDFW fish pathologist prior to placement in the net pens and would be monitored closely throughout their residence in the pens. A detailed health management program consisting of early detection of illness, monitoring of environmental conditions, best husbandry practices, good nutrition, and disease control and eradication shall be implemented (See Appendix III). Disease identification, control and reporting practices shall be conducted in accordance with state or federal regulatory requirements. Because the proposed project will implement a comprehensive health management program, disease impacts will be minimized to every extent possible and are considered to be insignificant.

Impact No. 6. Increased vessel traffic resulting from the proposed project may impact marine mammals and sea turtles.

The number of vessel trips in the area will increase as a result of this project. This increases the risk of potential collisions and other interactions between project vessels and federally protected marine mammals and sea turtles. Collisions with federally protected marine mammals and sea turtles that result in severe injury or death are considered to be a significant impact.

Between 1988 and 2012, there were 100 documented large whale ship strikes along the California coast. However, this number is likely under reported, potentially by as much as a factor of between five and fifty. Gray whales are the most commonly reported species involved in ship strikes off California, followed by fin, blue, humpback, and sperm whales. Young gray whales, especially, are more likely to be hit by moving vessels (Laist et al. 2001).

Blue whales pass through the SCB during their summer migration from Mexico and Central America. Over the last decade the blue whale population has spent increasingly more time in southern California waters, making the potential for interactions with this species in the project area more probable. In the last decade more than seven blue whales have beached along mainland coasts within the SCB. Four blue whales were found deceased off southern California within a few short weeks of one another in the fall of 2007. All are thought to have been the victims of ship strikes.

Watkins (1986), Malme et al. (1989), and Richardson et al. (1991) have reported that noises from vessels elicit a startle reaction from gray whales and can mask their reception capabilities. They also reported that avoidance and approach responses vary according to whale activity. Based upon the results of Wyrick (1954) and Bogoslovskaya et al. (1981), noise effects on migrating gray whales from vessels can be expected to be limited to within 656 to 1,804 feet (200 to 550 m) of approaching vessels, to be sublethal, and temporary.

Very little information describing pinniped responses to vessels is available. Johnson et al. (1989) reported that northern fur seals can be wary and show an avoidance reaction to vessels at distances of up to one mile (1.6 km). However, Wickens (1994) reported that fur seals are often attracted to fishing vessels to feed. Sea lions in the water often tolerate close and frequent approaches by vessels, especially around fishing vessels. Sea lions hauled-out on land are more responsive and react when vessels approach within 328 to 656 feet (100 to 200 m) (Peterson and Bartholomew 1967). Also, harbor seals often move into the water in response to vessels. Even small boats that approach within 328 feet (100 m) displace harbor seals from haul-out areas, and less severe disturbance can cause alert reactions without departure (Bowles and Stewart 1980; Allen et al. 1984; Osborn 1985).

Dolphins of many species tolerate or even approach vessels. Reactions to vessels often appear to be related to the dolphins' activity. Resting and foraging dolphins tend to avoid vessels, while socializing dolphins may approach them (Richardson et al. 1995).

Riedman (1983) reported that, while sea otters often allow close approaches by small boats, they tend to avoid high activity areas. He also noted that some rafting sea otters exhibit mild interest in vessels at distances of approximately 600 feet (183 m) and are not alarmed. However, Garshelis and Garshelis (1984) reported that sea otters in Alaska tend to avoid areas with frequent vessel traffic. Udevitz et al. (1995) also reported that sea otters tend to move away from an approaching vessel.

Noises from vessel traffic may elicit a startle reaction from marine turtles and produce a temporary sublethal stress (NRC 1990). A recent study investigating hearing capabilities in sea turtles indicates they hear best at frequencies <1,000 Hz (Piniak et al. 2012). Although turtles are estimated to be at the sea surface for less than four percent of the time (Byles 1989; Lohoefener et al. 1990), support vessels could collide with and injure marine turtles at the sea surface. Vessel-related injuries to turtles are rare in project waters but have been noted. In January 2004, an Olive Ridley with a cracked carapace stranded at Ellwood Beach following an apparent boat strike (NOAA 2007). In contrast, in the Gulf of Mexico, nine percent of stranded turtles examined showed signs of vessel-related injuries.

4.2.7.2 Mitigation Measures

Impact No. 1. Hard-bottom habitat, located within 1,600 m of project site and the fish pens, may potentially be impacted by the 500kg anchors and associated anchor chains that will be used to moor the fish cage grids.

***Mitigation Measure*:** Anchor contact with hard-bottom structures in the project area shall be avoided. If hard substrate is encountered, the mooring grids and anchors will be re-sited to avoid it. After initial installation of the fish pens, inspections shall be conducted on an annual basis and after major storms to verify that anchors have not migrated, or come into contact with hard-bottom structures. Anchors shall be repositioned if they contact or are in close proximity to hard-bottom features.

Impact No. 2. Wildlife may become entangled in the fish-pen nets.

Mitigation Measure: The applicant shall implement specific measures to minimize harmful interactions with wildlife (e.g., marine mammals, birds, fish and turtles). A specific goal is to avoid entanglement of marine birds, mammals, turtles, and predator fish species in the various nets that will be utilized at the RCF-SAP. As proposed by the applicant, the use of physical predator deterrence methods, such as anti-predator netting and locating the farm away from known seal and sea lion haul-out areas will be implemented. A description of the nets to be used and their placement are described in detail in section 2.3 of this report. The applicant shall consult further with the appropriate state and federal agencies regarding net mesh sizes that will be used for the fish pens, in order to minimize potential entanglement of marine wildlife. The applicant shall consider the recommendations for preventing harmful interactions with marine mammals issued by the Environmental Assessment Office, Government of Canada, as they apply to the current industry rules and regulations in the U.S. (e.g.-only physical deterrence methods, guarding, and proper storage of materials that may attract predators are allowed in the U.S. net pen aquaculture industry). The applicant shall abide by the regulations set forth in the U.S. Marine Mammal Protection Act as well as document and report any interactions with wildlife, to the appropriate state and federal agencies.

Impact No. 3. The deposition of uneaten fish food and fish feces on the seafloor may potentially alter the benthic community in the proposed project area.

Mitigation Measure: As required by the EPA as part of the NPDES permit process, a benthic monitoring program shall be initiated at the project site that is subject to review and approval by the EPA. The applicant has proposed a benthic monitoring program that includes monitoring of the health and community composition of benthic epi- and infaunal communities in addition to various physical and physiochemical measures. The proposed monitoring program incorporates adequate reference sites and satisfies BACI criteria. Additional information regarding the design of the monitoring program is provided in Section 4.1, Marine Water Quality, Mitigation Measure No. 2.

Impact No. 4. Cultured fish may escape from containment, impacting the genetic integrity of wild populations.

Mitigation Measure: As part of the project's best management practices, the applicant will develop and implement a comprehensive loss-control plan. At minimum, the plan will include: equipment standards, equipment installation protocols, preventative maintenance plans, integrated predator deterrence plans, and a containment management system that includes documentation of management actions and external audits. Plans should allow for continuous improvement and revisions as more innovations in farming methods and technology become available.

Impact No. 5. The pathogens or diseases associated with the cultured species may be transferred to wild fish stocks or to the fish community residing in the project area.

Mitigation Measure: A comprehensive health management program consisting of the early detection of infectious agents, monitoring of environmental conditions, good husbandry practices, good nutrition, and disease control and eradication, as proposed by the applicant, shall be implemented (See Appendix III). Disease identification, control and reporting practices shall be conducted in accordance with applicable state or federal regulatory criteria (See Section 2.7). Under this plan, disease outbreaks will be minimized. When an outbreak does occur, it will be detected quickly and controlled as rapidly as possible.

Impact No. 6. Increased vessel traffic resulting from the proposed project may impact marine mammals and sea turtles.

Mitigation Measure: Vessel operators shall be trained to recognize and avoid marine mammals and turtles during their transits to and from the project site and during their operations at the project site. Once trained, vessel operators shall be re-trained on an annual basis. At a minimum, vessel operators shall implement the following procedures should marine mammals be encountered at sea.

- Support vessels shall make every effort to maintain a distance of >1,000 feet from sighted whales and other endangered or threatened marine mammals and sea turtles.
- Support vessels will not cross directly in front of migrating whales.
- When paralleling whales, support vessels will operate at a constant speed that is not faster than the whales' speed.
- Female whales will not be separated from their calves.
- Support vessels will not be used to herd or drive whales or other marine life.
- If a whale engages in evasive or defensive action, support vessels would drop back until the animal calms or moves out of the area.
- Collisions or with marine wildlife shall be reported promptly to the federal and State agencies listed below pursuant to each agency's reporting procedures.

National Marine Fisheries Service
Justin Viezbicke, Stranding Coordinator, Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, CA 90802-4213
Phone: (562) 980-3230
Justin.Viezbicke@noaa.gov

California Department of Fish and Wildlife
3883 Ruffin Road
San Diego, CA 92123
(858) 467-4201

California State Lands Commission
Environmental Planning and Management Division
100 Howe Avenue, Suite 100 South
Sacramento CA 95825-8202
(916) 574-1900

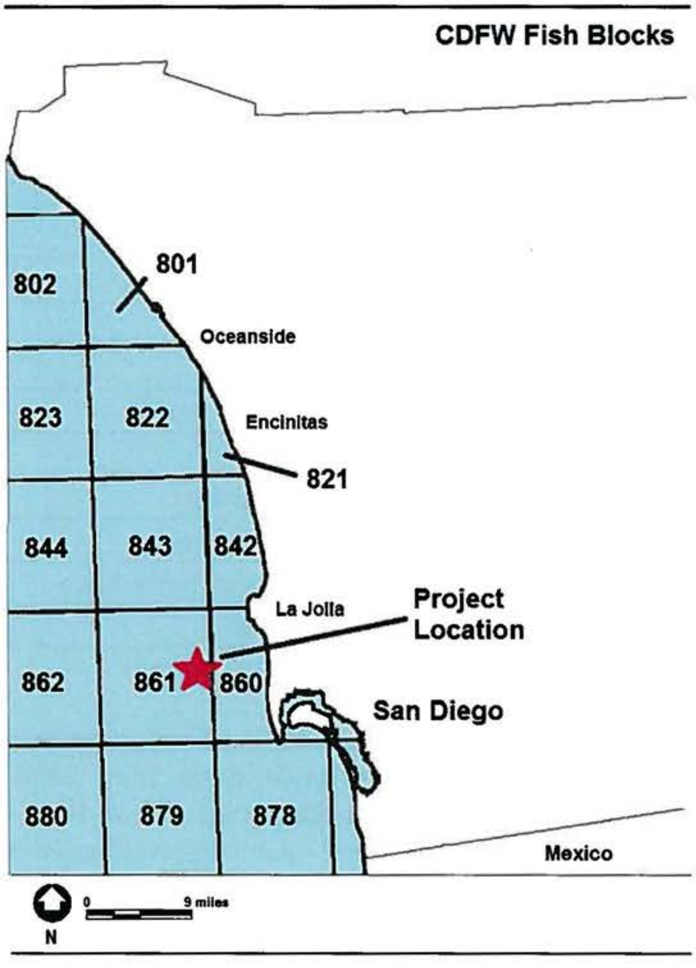
4.3 Commercial and Recreational Fishing

4.3.1 Environmental Setting

Commercial and recreational fishing activities occur at various locations within the project area. A wide variety of finfish and shellfish species are harvested in the project area, while kelp is harvested in specific beds that are managed by the California Department of Fish and Wildlife (CDFW). An analysis of fishery data collected around the project area for the six-year period from 2006 to 2011 forms the basis for the following summary of commercial and recreational fishing (CDFW 2012).

Fish blocks are statistical units used by CDFW to organize and report commercial and recreational harvesting of marine organisms off the California coast. Monthly catches are reported within rectangular blocks nominally covering 100 square miles (9 by 11-mile rectangular areas, or 278 km^2). However, where the coastline bisects such blocks, they cover proportionally smaller ocean areas. The two fish blocks highlighted in Figure 4.3-1 encompass an area of slightly less than 500 km^2 (193 square miles) and are used here to assess potential impacts from the proposed project on local commercial and recreational fisheries in the region. The proposed project lies 7.2 km (4.5 miles) offshore of Mission Bay, CA, near the eastern edge of Block 861, as shown on Figure 4.3-1. Fish Block 861 encompasses a small portion of the continental shelf before dropping down to the deeper waters of the continental slope.

Figure 4.3-1. CDFW Fish Blocks off the Southern California Coast



4.3.1.1 Commercial Fishing

Between 2006 and 2011, over 66 different fish taxa were harvested commercially within the offshore fish block in which the proposed project will be sited (Block 861). The 1,559-ton harvest was valued at $1.3 Million (M), and was primarily landed at two major, local ports: San Diego, and Mission Bay. Most of the remaining fish caught in the area were landed at either San Pedro or Terminal Island, to the north.

4.3.1.2 Regional Fisheries

In recent years, the bulk of the commercial catch in the immediate project area has consisted of only a few major taxonomic groups (Table 4.3.1). For example, between 2006 and 2011, market squid (*Doryteuthis opalescens*) represented 76% of the total biomass and more than a quarter of the total catch value reported from Block 861. Valued at over $73 million in 2010, market squid is currently both California's largest and most lucrative commercial fishery. Similarly, the Dover sole, thornyheads, and sablefish fishery, known as the DTS complex, is the most important element in the California groundfish fishery in terms of landed weight and ex-vessel value.

Table 4.3.1. Top 10 Fish Species Commercially Harvested in Block 861 from 2006 to 2011 by Weight and Value

	Total Weight (pounds)			Dollar Value		
Rank	**Taxon**	**Weight**	**Percent**	**Taxon**	**$ Value**	**Percent**
1	Market squid	1,184,308	76.0%	Thornyheads	369,477	26.4%
2	Thornyheads	92,893	6.0%	Market squid	339,043	24.2%
3	Swordfish	62,485	4.0%	Swordfish	222,588	15.9%
4	Shark, thresher	55,768	3.6%	Sablefish	170,171	12.2%
5	Sablefish	50,377	3.2%	Shark, thresher	95,316	6.8%
6	Rockfish	38,323	2.5%	Lobster	49,167	3.5%
7	Opah	21,316	1.4%	Rockfish	44,439	3.2%
8	Shark, shortfin mako	13,403	0.9%	White seabass	38,718	2,8%
9	White seabass	13,342	0.9%	Shark, shortfin mako	17,540	1.3%
10	Hagfishes	10,018	0.6 %	Opah	12,144	0.9%

Source: CDFW 2012.

Although accounting for just under 10% of the total biomass harvested from Block 861, the DTS complex represented nearly 40% of the total catch value from 2006 to 2011. Swordfish comprised nearly 16% of the remaining catch value within Block 861, while thresher sharks, shortfin mako, lobster, rockfish, white seabass and opah comprised most of the rest of the catch by value (<20%).

Table 4.3.2 lists the fish commercially harvested in Block 861 and the adjacent mainland block of 860. This block includes the Point Loma kelp beds and portions of the La Jolla kelp beds. The inclusion of Block 860 brings a dramatic shift in favor of nearshore and rocky species. Although market squid still dominates the catch in terms of biomass, urchin is a close second, with both comprising nearly 40% of the catch each. Additionally, with inclusion of the mainland block, lobster easily tops the catch in terms of value, representing nearly 60% of the total catch value, while urchin was second in terms of value at nearly 18%.

Similarly, other nearshore and rocky substrate species such as crab, Kellet's whelk, sea cucumber, sheephead, and prawn all show substantially higher when Block 860 is included.

Table 4.3.2. Top 10 Fish Species Commercially Harvested in Blocks 860 and 861 from 2006 to 2011 by Weight and Value

	Total Weight (pounds)			Dollar Value		
Rank	**Taxon**	**Weight**	**Percent**	**Taxon**	**$ Value**	**Percent**
1	Market squid	4,248,061	39.5%	Lobster	10,657,410	58.5%
2	Urchin	4,017,823	37.4%	Urchin	3,235,227	17.7%
3	Lobster	902,263	8.4%	Market squid	1,230,738	6.8%
4	Crab	257,849	2.4%	Sheephead	408,926	2.2%
5	Kellet's whelk	170,393	1.6%	Thornyheads	370,515	2.0%
6	Hagfishes	152,816	1.4%	Swordfish	337,271	1.8%
7	Bonito	146,323	1.4%	Prawn	278,750	1.5%
8	Swordfish	93,514	0.9%	Crab	253,053	1.4%
9	Thornyheads	93,177	0.9%	Sea cucumber	245,790	1.3%
10	Sheephead	85,940	0.8%	Kellet's whelk	153,597	0.8%

Source: CDFG 2012.

4.3.1.3 Gear

Market squid, an important commercial species in southern California that constitutes a substantial portion by both weight and value of the catch within the project area, is landed almost exclusively by purse seines (Vojkovich, 1998, CDFW 2012). Seines are essentially round haul nets that are used to encircle schools of pelagic fish or squid. Although there are several variations, these nets generally fish from the surface and the webbing of the net is laid out to encircle the selected prey species. Floats along the upper lead line keep the top end of the net at the water surface. Metal rings are sewn along the bottom edge and a cable is passed through the rings. When the cable is drawn tight, the net "purses" (Fields, 1965). Seines are used in the project area to capture squid and other pelagic species such as mackerel, sardine, and anchovy.

In prior years, high-intensity lamps were used to attract squid to the surface and a brail net was then used to scoop the squid onto the ship (Kato and Hardwick, 1975). Although brail or dip nets are still used, the vessels using these gear types have struggled to compete with the more efficient seiners and they currently contribute only a small portion of the total catch (Vojkovich, 1998, CDFW 2012).

Diving is the primary means used to harvest certain high value and nearshore species such as urchins and sea cucumbers. Although diving constitutes only a small percentage of the total harvest within Block 861, it is responsible for over 19% of the harvest by value and over 38% of the harvested biomass of the combined fish blocks (860 and 861).

Several variations on fishing methods that use hooks attached to lines are utilized in the project area. For example, trolling consists of towing a baited hook or lure behind a boat. Pelagic fish such albacore tuna are the primary target catch for trolling in the project area. Trolling commonly occurs in the water column high off the bottom.

Another hook and line method used in the project area is that of long-lining. Vertical longlines employ a series of hooks attached to a weighted line and is suspended vertically in the water column. Vertical long-lining is commonly used to fish for rockfish over hard-bottom structures. Horizontal bottom longlines are similar to vertical longlines except that the hooks lay on the seafloor. Weighted ends keep the line on the seafloor. Horizontal longlines are typically used to catch bottom fish such as halibut and sablefish.

Hook and line methods were responsible for less than 4% of the catch in Blocks 860 and 861 by value. A similar percentage of the catch (4%) value was harvested using gill nets.

Pots and traps constitute another prevalent method of capture in the project area, accounting for 3% of the biomass and nearly 65% of the value of the catch in fish blocks 860 and 861. Traps are used primarily to target high value species such as crab, lobster, and to a lesser extent, prawns and certain fish species (e.g. sheephead, rockfish, sablefish and hagfish). Over the last decade a burgeoning commercial fishery has even developed for Kellet's whelk, which is typically captured as by-catch in lobster and crab traps.

Pots and traps come in a variety of shapes and sizes. Typically, several pots or traps are attached to a heavy ground line with an anchor or heavy weights attached at both ends. The ends of the line are connected to a surface buoy containing markers such as flags, radar reflectors or even lights. Crab pots in particular are set in hard-bottom habitats. They can be set individually or in groups attached to a common ground line. During installation and retrieval of traps and pots, they may be dragged for several meters along the seafloor. Pots and traps are generally used at water depths <200 m near hard bottom habitat or along edges of canyons. However, pot fishing for sablefish can occur at depths up to 500 m along the edge of the continental shelf.

Commercial fishers can be impacted should significant and important fishing grounds be removed from fishing due to obstructions caused by the proposed fish pens. However, worse case calculations reveal that for the proposed pens, a total benthic footprint of 3.25 km^2 would be removed from fishing. Based on the commercial fishing activities in the project area, the area lost to commercial fishing is expected to be minimal. Based on historical catch data, the value of fishes lost to commercial fishers from the proposed project is minimal. Catch data reveal that the high dollar species are predominantly nearshore species or pelagic species that are primarily caught in other offshore areas. Hence, impacts to commercial fishing are expected to be minimal and not significant.

Recreational fishing activities in the project area occur from a variety of locations or platforms. They include private or charter vessels, piers, or from the shoreline (e.g., beaches, jetties, breakwaters). Other than fishing logs maintained by the commercial passenger fishing vessel (CPFV) fleet, reliable recreation fish landing data for specific locations of the coast are not available.

As with commercial fishing, impacts to recreational fishing activities would be minimal and not significant. Most of the recreational fishing activity offshore San Diego occurs in the nearshore areas of the mainland and around the offshore islands. Although significant recreational rockfish fishing occurs over hard-bottom structures in the nearshore zone, the nearest hard-bottom habitats are located over 1,600 m from the site, and would be avoided during placement of the net pens and mooring grid. It is also possible that the proposed project would enhance fishing opportunities to recreational fishers. From example, diver surveys by Oakes and Pondella (2009) found higher fish abundance, density and diversity below cages stocked with white sea bass off Catalina Island as compared to both nearby and distant reference reefs. In addition to the presence of uneaten fish feed that drifts and settles in the area, wild fish may also be attracted to the vertical structure supplied by the fish cages and use them as shelter or for foraging on the fouling communities (Price and Morris 2013). Should this occur, beneficial impacts to recreational fishing may result from the proposed project.

4.3.1.4 Kelp

Kelp beds in the project area are dominated by giant kelp (*Macrocystis pyrifera*), and form an important and distinct marine habitat along the rocky coastal reaches of the Bight. Although 75 percent of the kelp ecosystems of the Southern California Bight exist within the nearshore waters of the Channel Islands, the relatively calm conditions off La Jolla and Point Loma also provide a particularly hospitable environment. Kelp beds grow within the euphotic zone located beyond the surf zone. The euphotic zone is restricted to depths where ambient light intensity exceeds roughly one percent of surface illumination, which is the minimum necessary for phytoplankton growth. The Point Loma kelp forest is located on a broad, mudstone-sandstone terrace offshore of San Diego, California (32° 42' N; 117° 16' W), and is approximately 8-10 km long by 1 km wide (City of San Diego, 2003).

The outer limit of giant kelp beds is largely determined by water clarity. Historically, large kelp beds have been found to extend as much as one mile (1.6 km) from shore (Arthur D. Little, Inc., [ADL] 1984). Kelp is also sensitive to water temperature. For example, during the El Niño events in 1992 and 1997 the Santa Barbara Channel kelp beds died back substantially. The kelp beds began to reestablish themselves within some areas of the Channel during the subsequent La Niña event, when cooler water temperatures prevailed.

Kelp beds provide habitat for many types of adult and juvenile fish, marine mammals, and marine invertebrates. Kelp usually attaches to rock outcrops or large cobbles to stay in place. In addition to providing habitat, kelp may be harvested both individually and commercially for a variety of uses. Extracts from brown kelp (alginates) are commonly used as thickening, stabilizing, suspending, and gelling agents in a wide variety of food, paper, pharmaceutical, cosmetic, and dental products. Formerly, Kelco Inc. harvested large quantities of giant kelp from offshore areas near the project location and throughout southern California. However, in 2005, this company relocated much of its infrastructure, and commercial kelp harvesting off the coast of California has since declined substantially in terms of the tonnage harvested. However, mariculture companies are increasingly using giant kelp as food for their abalone stock.

As with commercial and recreational fishing, impacts to kelp harvesting activities would be minimal and less than significant. Regardless, the project site is located well offshore from the furthest extent of the mainland Point Loma and La Jolla kelp beds, and impacts to the kelp beds from nutrient loading or turbidity increases resulting from the project are not expected.

4.3.2 Project Impacts and Mitigation Measures

The sections that follow present the commercial and recreational fishing impacts and mitigation measures associated with the proposed project.

4.3.2.1 Project Impacts

Impact No. 1. The proposed project would result in adverse impacts to commercial fishing operations in the San Diego area.

Commercial fishing could be impacted if important fishing grounds or large offshore areas become unavailable to fishing operations. Under the proposed project, fishing grounds would become unavailable to fishing due to the placement of fish pens that would be moored in an anchoring grid to the seafloor.

Although the physical area the net pens will encompass at the sea surface is .24 km^2 x 2 grids, the anticipated anchoring grid footprint on the seafloor for the project is 1.62 km^2 x 2 grids. Therefore, calculations indicate that a total benthic area of 3.25 km^2 could be removed from fishing operations. However, historical catch data reveal that high value species are not fished in the project area but instead, are caught in other offshore locations, or closer to rocky shores along the mainland. For example, important shellfish species (lobster) predominantly occur in nearshore environments while pelagic species (e.g., swordfish, thresher sharks, squid) are generally caught throughout the region. For these reasons, impacts to commercial fishing operations from the loss of access to the immediate project area are expected to be minimal and not significant.

Impact No. 2. The proposed project would result in adverse impacts to recreational fishing activities in the San Diego area.

Adverse impacts to local recreational fishing activities are not expected to occur as the majority of recreational fishing activity occurs in nearshore areas of the mainland and other offshore areas. Although rockfish fishing occurs over hard-bottom structures in the region, these substrates would be avoided and instead, the fish pens would be placed in soft-bottom substrate. Lastly, recreational fishing opportunities may increase in the general vicinity of the proposed project as fish from other locations may be attracted to uneaten fish feed as it drifts or settles to the ocean floor.

4.3.2.2 Mitigation Measures

Impact No. 1. The proposed project would result in adverse impacts to commercial fishing operations in the San Diego area.

Mitigation Measure: To the maximum extent possible, the fish cages shall be placed in the smallest footprint possible without compromising water or sediment quality. This placement would minimize the area potentially lost to commercial fishing operations.

Mitigation Measure: The mitigation measure regarding Avoidance of hard-bottom structures, Marine Biological Resources, Section 4.1.2, also applies to this impact.

Impact No. 2. The proposed project would result in adverse impacts to recreational fishing activities in the San Diego area.

Mitigation Measure: The two mitigation measures for impacts to commercial fishing (above) would also apply to recreational fishing impacts. No additional mitigation measures are needed.

4.4 Marine Traffic

4.4.1 Environmental Setting

There are three broad categories of vessels that traverse the project area: 1) large commercial vessels that transit through the area, 2) local work boats (e.g., tour boats and fishing boats), and 3) recreational boaters.

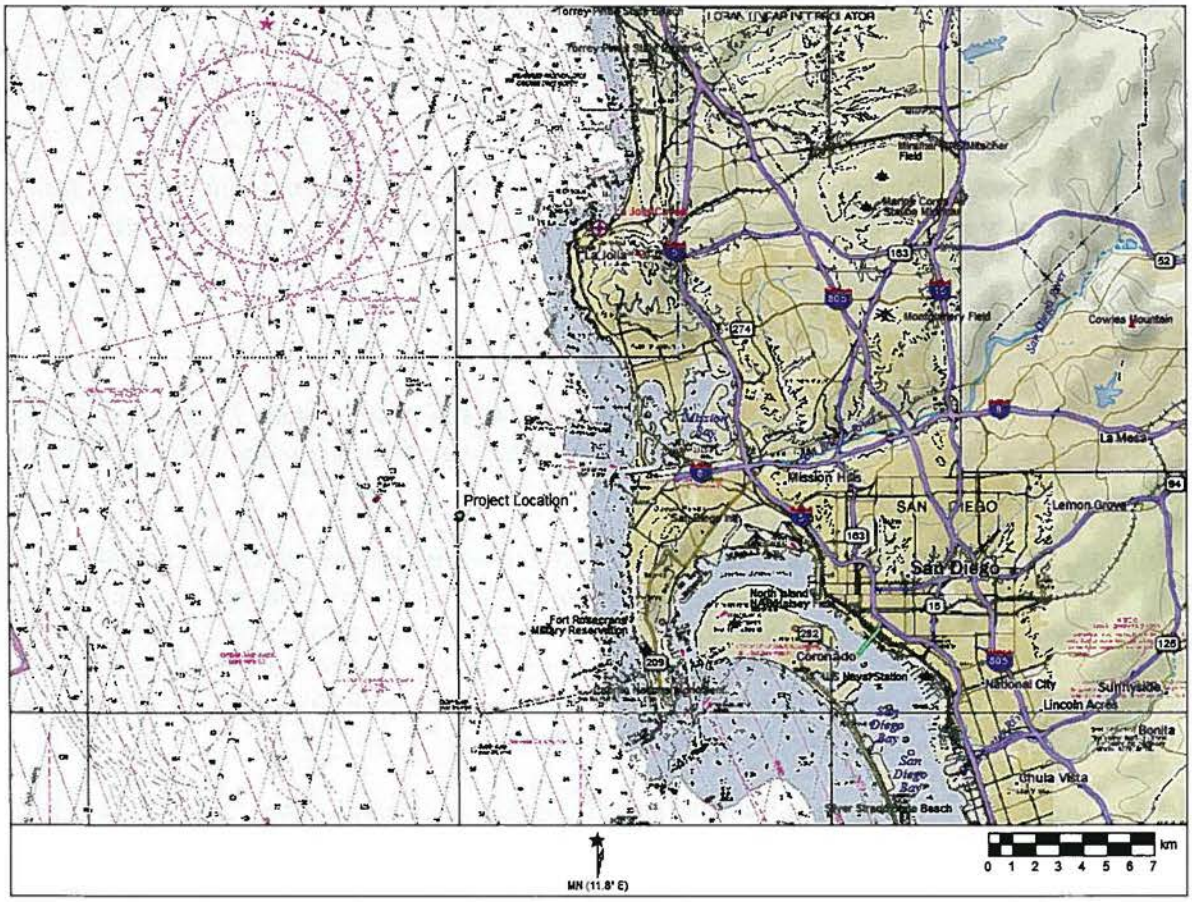
San Diego Bay is an active commercial harbor with two commercial wharves operated by the Port of San Diego, and numerous commercial fishing wharves as well. There is also heavy vessel traffic from the U.S. Navy. Approximately 82,413 vessel transits occurred in 2009 (San Diego Harbor Safety Committee, 2013). Of this total, approximately 78,094 were considered shallow draft vessels (draft of less than 18 feet), while the remaining deep draft vessels (4,319) would be generally categorized as having drafts in the 25-41 foot range.

There are four Port District maintained launch ramps throughout San Diego Bay, and an additional five in Mission Bay. These are located in:

- San Diego – Shelter Island;
- National City – Pepper Park, adjacent to the 24th Street Marine Terminal;
- Chula Vista – J Street Park;
- Coronado – Glorietta Bay; adjacent to the Municipal Pool
- Mission Bay – De Anza Cove;
- Mission Bay – Dana Launch Ramp;
- Mission Bay – South Shore Ramp;
- Mission Bay – Ski Beach Vacation Isle; and
- Mission Bay – Campland by the Bay.

The proposed project in not located in, or immediately adjacent to, any established vessel transportation corridors. The area surrounding the proposed project is considered a regulated navigation area as shown in Figure 4.4-1.

Figure 4.4-1. Marine Vessel Navigation



Marine vessel accidents include vessel "allisions" (between a moving vessel and a stationary object, including another vessel), collisions (between two moving vessels), and vessel groundings; collectively known as vessel allisions, collisions, and groundings or ACGs. Large vessels are typically involved in about 11 percent of all marine incidents or only 7.7 percent of ACG incidents (U.S. Naval Academy 1999). (In addition to ACG incidents, "all incidents" also include events such as electrical power loss, flooding, personnel injury, pollution, and abandonment.) The largest number of accidents involved tug boats and barges. Table 4.4-1 lists accident rates reported by different studies.

Table 4.4.1. Vessel Accident Rates

Study/ Source	Years (Range)	Ships/Conditions Involved	Type of Accident	Probability per transit (percent)
MIT	1981-95	All ships	All accidents	0.065–0.11
USCG	1992-98	All U.S. ports, deep draft only	ACGs	0.20
USCG	1992-98	Ships only	At sea collisions	0.013
USCG	1992-98	Ships only	At sea groundings	0.010
USCG	1992-98	Ships only	At sea allisions	0.0082
FEMA	1980-1988	In harbors/bays	Collisions and groundings	0.10
FEMA	1980-1988	In harbors/bays	Collisions while moored	0.02

Source: MIT 1998; U.S. Naval Academy 1999; FEMA 1989, Harbor Safety Committee 2007.

Note: These commercial vessel accidents meet a reportable level defined in 46 CFR 4.05, but do not include commercial fishing vessel or recreational boating casualties.

4.4.2 Project Impacts and Mitigation Measures

The sections that follow present the traffic impacts and mitigation measures associated with the proposed project.

4.4.2.1 Project Impacts

Impact No. 1. The frequency of vessel collisions in the project area will increase due to the supply vessels that will be used to support the proposed project.

Based on the number of project-related transits to and from San Diego Harbor, a worst-case estimate of a vessel ACG can be estimated using the MIT probability for all accidents. Based on the average probability, the worst-case annual probability for a project-related vessel ACG would be approximately 0.32 per year.

Impact No. 2. Vessels that transit through or operate in the project area can accidentally run into the project fish pens.

Large commercial vessels that transit through the Southern California Bight travel in established corridors and traffic lanes (VTSS) that are marked on navigational charts. The proposed project would be located outside a VTSS, and the fish pens would be well-marked. It is therefore unlikely that large commercial vessels would collide with the project fish pens. Commercial vessels are generally staffed with professional and experienced personnel, are equipped with current navigational and radar equipment, and captained by personnel that are very familiar with local offshore structures or installations. Commercial operators will be fully informed of the project and location of the fish pens so it is highly unlikely that accidents involving them will occur.

Nevertheless, based on the number of larger vessels that transit to and from San Diego Harbor, a worst-case estimate of a larger vessel allision with the proposed project can be estimated using the USCG probability for open-ocean allisions. Based on the average for ships, the worst-case annual probability for a ship/project allision, assuming all vessels transit near the proposed project, would be approximately 0.12 per year. However, since a large number of vessel transits would not take place near the proposed project site, the actual probability of an allusion would likely be much lower.

Recreational vessels that operate out of local harbors pose the largest threat to the fish pens. Unlike commercial vessels, recreational vessels are not always equipped with up-to-date navigational and radar equipment and can be skippered by inadequately trained personnel that are not familiar with local conditions or offshore structures.

4.4.2.2 Mitigation Measures

Impact No. 1. Vessels that transit through or operate in the project area can accidentally run into the project fish pens.

Mitigation Measure: Vessel operators shall be notified of the project and its location. A project announcement should be posted in the Notice to Mariners (USCG publication). The U.S. Department of Commerce, NOAA, shall also be notified so navigational charts can be updated to show the location and extent of the fish pens. Additionally, the fish pens shall be marked with lights and radar reflectors mounted onto surface buoys in accordance with USCG regulations (72 COLREGS and all amendments), and as determined by the issuance of the USCG Aids to Navigation Permit.

Mitigation Measure: Notices that describe and illustrate the net pen locations and markings shall be posted at the Harbor Patrol or Harbor Masters offices at the two regional harbors (San Diego and Mission Bay).

Mitigation Measure: Monitors at the project site will contact vessels or boaters by marine radio if they approach too close to the net pens. Boaters should be notified by the monitors of potential conflicts and hazards.

Impact No. 2. The frequency of vessel collisions in the project area will increase due to the increase in traffic from the supply vessels that will be used to support the proposed project.

Mitigation Measure: The Mitigation Measures for Impact No. 1 apply.

4.5 Marine Cultural Resources

Historical and cultural resources are defined as those areas of the marine environment that possess historical, cultural, archaeological or paleontological significance, including sites, structures, or objects significantly associated with, or representative of earlier people, cultures and human activities and events. Historical and cultural resources in the marine environment may generally be categorized into prehistoric remains, inundated cities, harbors, shore installations, and ship and aircraft wrecks.

4.5.1 Environmental Setting

The study area for this section includes those areas extending out from the net pens to the furthest potential anchor location that would be required to maintain the cages in the required positions. This generally includes all areas within about 400 meters of the mooring grid's perimeter.

4.5.1.1 Prehistoric Maritime Potential

Potential for Submerged Subaerial Sites of Human Occupation

At the height of the Wisconsin glaciation approximately 18,000 to 24,000 years ago, sea level was as much as 120m (400 ft, 66 fathoms) below its present altitude (Milliman & Emory 1968), which would place the project location in an area that would have been above sea level. Human populations have been on the California coast for at least the past 13,000 years (Johnson 1999) and are known to have occupied and exploited the products of the littoral zone for much of that time (Jones 1992). It is reasonable to assume that their occupation sites within this zone were drowned by sea level rise (the Holocene transgression) inland across the shelf till stabilizing near the present altitude between 7,000 and 9,000 years ago (Richards 1971, Bloom 1977). Conditions for preservation of these submerged sites vary with site type and local topography, but it is generally believed that in certain protected environments some sites would have survived the encroaching 'wave mill' of post-Wisconsin transgression (Shepard 1964, Bickel 1978).

Prehistoric settlement patterns projected offshore suggest culturally-sensitive locations occur near the confluence of perennial streams and where these streams traverse a coastal bluff or beach (Stright 1987). Estuary topography in the form of bay mouth bars, tombolos, and backshore beaches as well as nearby bluffs are also sensitive locations for the potential survival of buried prehistoric archaeological occupation and activity sites.

To date the occurrence of drowned Pleistocene subaerial sites of human occupation during periods of lowered sea level, within the environs of the offshore study area are fairly well characterized. Geotechnical studies incorporating the acquisition of continuous cores suitable to environmental reconstruction, together with high-resolution subbottom profiler studies and other analytical techniques that were prepared to characterize the area as part of the oil development project, can provide evidence of such relictual landforms as contain data useful to the discovery and investigation of prehistoric human presence in these submerged landscapes.

Prehistoric Watercraft Traditions

Most maritime people around the world developed some type of watercraft with which to traverse bodies of water, as well as avail themselves of such resources as were otherwise denied to them, except by conveyance. From the skin baidarka or kayak of the arctic Eskimo to the sleek tule reed craft of South America, Native Americans have as wide a range of incipient watercraft development as utilized anywhere. Within maritime regimes, much depended on the desires of the aboriginal population and the availability of materials for implementing solutions. Rivers, inlets, lagoons, islands and difficult coasts all inspire human creativity in finding answers to problems of transport and access.

Historic Maritime Exploration, Settlement and Commerce

The prehistoric and historic maritime activities in the environs of the project area provide the context for review and analysis of the geophysical survey data of the project area. The significant number of shipwrecks within the area can largely be attributed to prevailing currents and weather conditions, combined with natural hazards. The shipwreck remains in the vicinity of the project site reflect the diverse range of activities and nationalities that traversed the region. European sailing and steam vessels, California built Chinese junks, American coastal traders, vessels engaged in island commerce and a Gold-Rush-era side-wheel steamer, have all been lost in these waters.

Archaeological sites on the OCS are most likely to be either prehistoric Native American sites dating from the time at the end of the last Ice Age, when sea levels were about 400 feet lower than they are today, or historic shipwrecks. The oil and gas industry is required to conduct surveys of the seafloor using remote-sensing instruments in areas where archaeological sites are likely to be found. These instruments usually include a magnetometer, which detects ferrous metals; side-scan sonar, which creates a picture of the seafloor using reflected sound waves; and a sub-bottom profiler, which detects variations in the sediment underlying the seafloor.

4.5.2 Regulatory Setting

4.5.2.1 Applicable Federal Regulations

Federal laws, regulations and policies were reviewed for application to the project location within waters of the State of California. As no submerged cultural resources have been identified thus far in the investigation process, any application of jurisdiction is premature. However, shipwrecks discovered in federal waters would be covered under the federal Abandoned Shipwreck Act.

State Regulations

State Lands Commission Policy

The project area is restricted to lands controlled by the State of California and as such, the regulatory setting is founded in the California Environmental Quality Act (CEQA). Also, because of legislative changes that took effect in February 1999, the California State Public Resources Codes, in particular sections 5020.0, 5024.1, 15064.5, 15064.7, 21808.1, and 21083.2 regulate this project.

Generally, CEQA requires public agencies to seek to avoid damaging effects on an archaeological resource whenever feasible. In situ preservation of a site is more important than preserving the artifacts alone because the relationship of the artifacts to each other in the site provides valuable information that can be lost when the artifacts are removed. Further, preserving the site keeps it available for more sophisticated research methods.

Congressional Shipwreck Act of 1987

This Congressional legislation transferred ownership of submerged historic shipwrecks imbedded in State Water's bottomlands to State ownership. There is nothing yet observed within the study area that would invoke the provisions of this Act.

California Coastal Act of 1976

This act requires anyone who proposes any development in the coastal zone to secure a Coastal Development Permit from either the California Coastal Commission or local jurisdiction with a certified Local Coastal Program. Section 30244 of the act provides that "Where development would adversely impact archaeological or paleontological resources as identified by the State Historic Preservation Officer, reasonable mitigation measures shall be required." The California Coastal Commission would review the project under their authority delegated by the federal government under the Coastal Zone Management Act.

4.5.3 Thresholds of Significance

Determining the Significance of Impacts to Archaeological and Historical Resources and Unique Archaeological Resources (CEQA 15064.5) would be based on the following criteria. It is expected that archaeological and historical resources in the offshore region would focus on potential impacts to shipwrecks, as listed in the State Lands Commission Shipwreck Database, or potential impacts to previously undiscovered shipwrecks or archaeological/historical items.

1) An historical resource is a resource listed in, or determined to be eligible for listing in the California Register of historical Resources (Pub Res. Code 5024.1, Title 14 CCR, Section 4800 et seq.)

2) A resource included in a local register of Historical resources, as defined in section 5020.1(k) of the Public Resources Code or identified as significant in an historical resource survey meeting the requirements of Section 5024.1(g) of the Public Resources Code, shall be presumed to be historically or culturally significant. Public agencies must treat any such resource as significant unless the preponderance of evidence demonstrates that it is not historically or culturally significant.

3) Historical resources may include, but are not limited to, any object, building, structure, site, area, place, record or manuscript which a lead agency determines to be historically or archaeologically significant or is significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military or cultural annals of California may be considered to be an historic resource, provided the lead agency 's determination is supported by substantial evidence in light of the whole record.

4) Criteria for listing on the California Register of Historical Resources (Pub. Res. Code 5024.1, Title 14 CCR, Section 4800.3) would be consulted in determining if an historical resource may be eligible for listing, as follows:

   A. It is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;

   B. It is associated with the lives of persons important to our past;

   C. Embodies the distinctive characteristics of a type, period, region or method of construction, or perhaps the work of an important creative individual, or possesses high artistic values; or

D. Has yielded, or may be likely to yield, information important in prehistory or history.

5) The fact that a resource is not listed in, or determined to be eligible for listing in the California Register of Historical Resources, not included in a local register of historical resources (pursuant to Section 5020.1 (k) of the Public Resources Code), or identified in an historical resources survey (meeting the criteria in Section 5024.1(g) of the Public Resources Code) does not preclude a lead agency from determining whether the resource may be an historical resource as defined in Public Resources Code Sections 5020.1(j) and 5024.1.(b). A project with an effect that may cause a substantial adverse change in the significance of an historical resource is a project is a project that may have a significant effect on the environment.

   A. Substantial adverse change in the significance of an historical resource means physical demolition, destruction, relocation or alteration in the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired.

   B. The significance of an historical resource is materially impaired when a project:

      1) Demolishes or materially alters an in an adverse manner those physical characteristics of an historical resource that convey its historical significance and that justify its inclusion in, or its eligibility for, inclusion in the California Register of Historical Resources; or

      2) Demolishes or materially alters in an adverse manner those physical characteristics that account for its inclusion in a local register of historical resources pursuant to section 5020.1 (k) of the Public Resources Code or its identification in an historical resources survey meeting the requirements of section 5024.1 (g) of the Public Resources Code, unless the public agency reviewing the effects of the project establishes by a preponderance of evidence that the resource is not historically or culturally significant; or

      3) Alters or demolishes or materially alters in an adverse manner those physical characteristics that account for a determination by a lead agency, based on substantial evidence in light of the whole record, that the resource is an historical resource for purposes of CEQA.

   C. A lead agency shall identify any potentially feasible measures to mitigate significant adverse changes in the significance and historical resource. The lead agency shall ensure that any adopted measures to mitigate or avoid significant adverse change are fully enforceable through permit conditions, agreements or other measures.

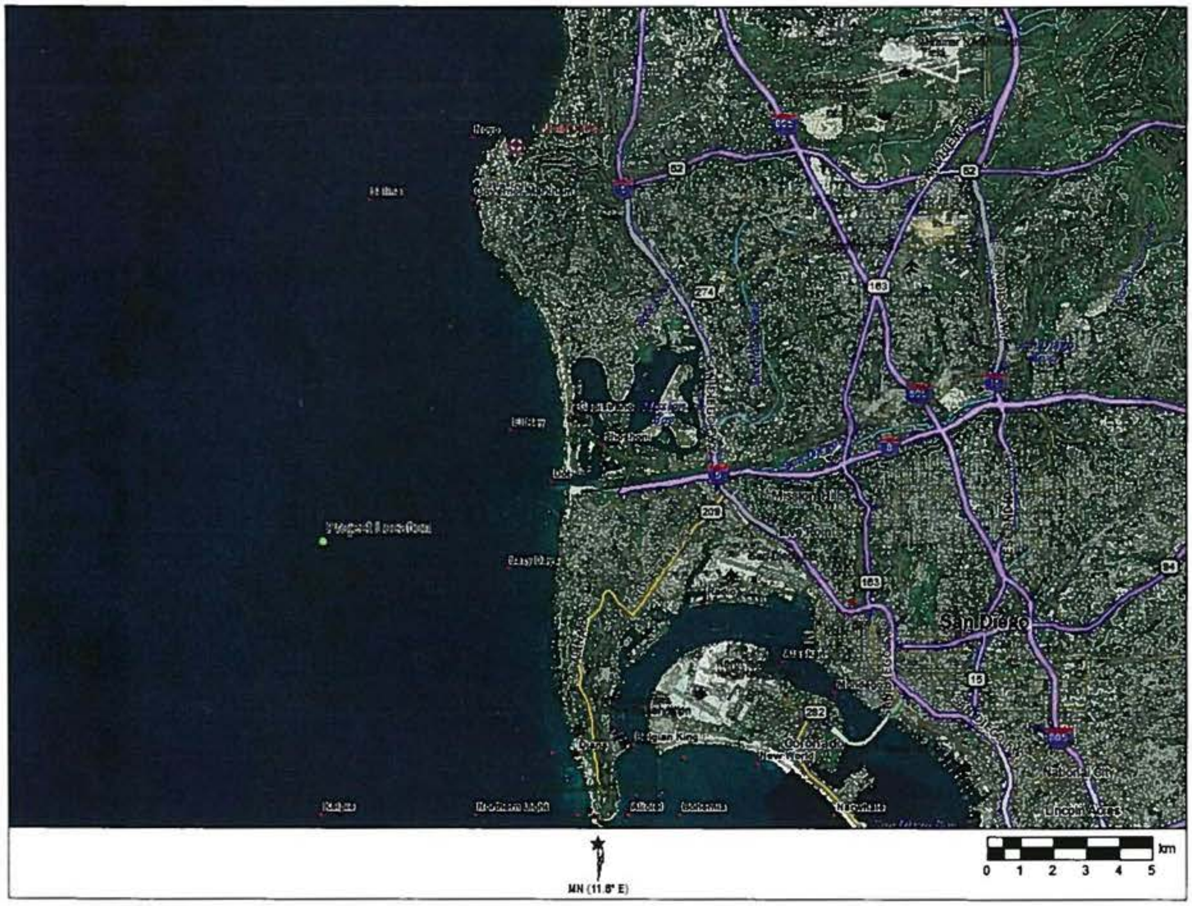
4.5.4 Impact Assessment and Methodology

The marine cultural resource impact analysis consisted of a literature review and a review of side scan sonar and magnetometer data. This approach allows for the evaluation of the proposed project on known and unknown resources of potential cultural value.

Literature and site record searches for the project area were conducted to evaluate the potential for the presence of archaeological resources. Information was obtained from the Minerals Management Service, J. Porter Shaw Library at the National Maritime Museum in San Francisco, Bancroft Library of the University of California, Berkeley; U.S. Army Corps of Engineers and Commerce Department files at the National Archives in Washington D.C., as well as the Regional Records Centers of San Bruno and Laguna Nigel in California, the Huntington Library in San Marino, the Special Collections department of the Cal Poly San Luis Obispo Kennedy Library, Northwest Information Center of the California Archaeological Inventory at California State University at Sonoma, the California State Library and the State Archives and Records Office. The National Parks Service, Scripps Institute of Oceanography and the California State Lands Commission shipwreck database were also consulted.

Results of the literature search identified the presence of numerous archaeological resources in the region, but none within the immediate project area. Figure 4.5-1 shows the nearest shipwrecks to the proposed project site.

Figure 4.5-1. Shipwrecks in the Project Vicinity



4.5.5 Project Impacts and Mitigation Measures

The sections that follow present the marine cultural resources impacts and mitigation measures associated with the proposed project.

4.5.5.1 Project Impacts

Impact No. 1. While the project anchors are not expected to extend to the location of any known seafloor feature, unknown seafloor features could still be encountered.

A minimum of two anchors would be used to moor each of the 24 proposed fish cages to the seafloor within each of two mooring grids (see mooring diagram in Appendix II). Although the physical area the net pens will encompass at the sea surface is .24 km^2 x 2 grids, the anticipated anchoring grid footprint on the seafloor for the project is 1.62 km^2 x 2 grids. Placement of anchors could disturb or damage as yet unidentified cultural resources on the seafloor within the project area.

4.5.5.2 Mitigation Measures

Impact No. 1. While the project anchors are not expected to extend to the location of any known seafloor feature, unknown seafloor features could still be encountered.

Mitigation Measure: During the installation of anchors, seafloor features shall be avoided by a minimum distance of 100 meters. At no time shall any seafloor feature be allowed to lie between an anchor and the cages where the anchor chain could damage a potentially significant cultural resource.

Mitigation Measure: Should a previously unknown shipwreck of potential cultural resource value be discovered within the project area, the proposed project anchoring scheme shall be modified to avoid the potential cultural resource.

Residual Impact

Implementation of the above mitigation measures would avoid disturbing known and previously unknown shipwrecks of potential cultural resource value. Therefore, this impact is considered insignificant.

5.0 Coastal Zone Management Act Consistency

5.1 Marine Resources and Water Quality

Coastal Act Section 30230 states:

Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.

Coastal Act Section 30231 states:

The biological productivity and the quality of coastal waters, streams, wetlands. estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff preventing depletion of ground water supplies and substantial interference with surface water flow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.

Sections 4.1 and 4.2 provide analyses of potential project-related impacts to marine biological resources and marine water quality, respectively. Results of these analyses indicate that potential impacts to marine resources will be minimal and can be further minimized with additional mitigation. Given the low magnitude of potential impacts, the project should be considered consistent with these sections of the Coastal Act.

5.2 Oil Spills

Coastal Act Section 30232 states:

Protection against the spillage of crude oil, gas, petroleum products, or hazardous substances shall be provided in relation to any development or transportation of such materials. Effective containment and cleanup facilities and procedures shal1 be provided for accidental spills that do occur.

The proposed project would not utilize any petroleum-related products. An 80 to 100-foot work boat will be utilized for aquaculture operations, but the number of boat trips would be minor when compared to existing regional vessel traffic. Therefore, the project will not substantially increase the number of boat trips nor the potential for increased oil spill risk over current baseline conditions. Therefore, the proposed project would be consistent with this section of the Coastal Act.

5.3 Dredging and Placement of Fill in Coastal Waters

Coastal Act Section 30108.2 defines "fill" as "earth or any other substance or material, including pilings placed for purposes of erecting structures thereon, placed in a submerged area." The anchors that will be placed on the seafloor constitute fill as defined in Coastal Act Section 30108.2.

Coastal Act Section 30233(a) states in part:

The diking, filling, or dredging of open coastal waters, wetlands, estuaries, and lakes shall be permitted in accordance with other applicable provisions of this division where there is no feasible less environmentally damaging alternative, and where feasible mitigation measures have been provided to minimize adverse environmental effects, and shall be limited to the following:

(1) *New or expanded port, energy, and coastal-dependent industrial facilities, including commercial fishing facilities.*

(2) *Maintaining existing, or restoring previously dredged depths on existing navigational channels, turning basins, vessel berthing and mooring areas, and boat launching ramps.*

(3) *In wetland areas only, entrance channels for new or expanded boating facilities; and in a degraded wetland, identified by the Department of Fish and Game pursuant to subdivision (b) of Section 30411, for boating facilities if; in conjunction with such boating facilities, a substantial portion of the degraded wetland is restored and maintained as a biologically productive wetland. The size of the wetland area used for boating facilities, including berthing space, turning basins, necessary navigation channels, and any necessary support service facilities, shall not exceed 25 percent of the degraded wetland.*

(4) *In open coastal waters, other than wetlands, including streams, estuaries, and lakes, new' or expanded boating facilities and the placement of structural pilings for public recreational piers that provide public access and recreational opportunities.*

(5) *Incidental public service purposes, including but not limited to, burying cables and pipes or inspection of piers and maintenance of existing intake and outfall lines.*

(6) *Mineral extraction, including sand for restoring beaches, except in environmentally sensitive areas.*

(7) *Restoration purposes.*

(8) *Nature study, aquaculture, or similar resource dependent activities,*

Coastal Act Section 30233(a) restricts the Coastal Commission from authorizing a project that includes dredging and open coastal water fill unless it meets the "allowable use" test. To meet this test, the activities must fit into one of eight categories of uses enumerated in Coastal Act Section 30233(a)(I)-(8). One of the eight allowable uses of fill under 30233(a)(I) is a coastal-dependent industrial facility. The proposed aquaculture activities are "coastal-dependent" since they require "a site on, or adjacent to, the sea to be able to function at all" as defined in Coastal Act Section 30 10 I, and aquaculture activities are specifically identified in Category 8 above. Therefore, the proposed project meets the allowable use test of Coastal Act Section 30233(a).

5.4 Commercial and Recreational Fishing

Coastal Act Section 30234.5 states:

The economic, commercial, and recreational importance of fishing activities shall be recognized and protected.

The proposed project would not substantially interfere with commercial and recreational fishing. No coastal areas would be affected by the project, and only a small offshore area, more than 7 kilometers from the shoreline, would be occupied by the project. Anchors on the seafloor, and their associated surface tag lines and buoys, would extend beyond the net pens, but would not substantially limit commercial or recreational fishing. Therefore, the project would not interfere with commercial and recreational fishing, and would be consistent with this section of the Coastal Act. See Section 4.3 for an analysis of potential project-related impacts to commercial and recreational fishing.

5.5 Public Access and Recreation

Coastal Act Section 30211 states:

Development shall not interfere with the public's right of access to the sea where acquired through use or legislative authorization, including, but not limited to, the use of dry sand and rocky coastal beaches to the first line of terrestrial vegetation.

Coastal Act Section 30220 states:

Coastal areas suited for water-oriented recreational activities that cannot readily be provided at inland water areas shall be protected for such uses.

The proposed project would not substantially interfere with coastal access and recreation. No coastal areas would be affected by the project, and only a small offshore area, more than seven kilometers from the shoreline, would be occupied by the project. Anchors on the seafloor, and their associated surface tag lines and buoys, would extend beyond the net pens, but would not limit public access. Therefore, the project would not interfere with public access and recreation, and would be consistent with this section of the coastal act.

5.6 Cultural Resources

Coastal Act Section 30244 states:

Where development would adversely impact archaeological or paleontological resources as identified by the State Historic Preservation Officer, reasonable mitigation measures shall be required.

Historical and cultural resources are defined as those areas of the marine environment that possess historical, cultural, archaeological or paleontological significance, including sites, structures, or objects significantly associated with, or representative of earlier people, cultures and human activities and events. Of concern here is the potential for anchor-laying activities to disturb or damage shipwrecks of potential cultural resource value.

A review of side scan sonar and magnetometer data sets conducted as part of the environmental evaluation concluded that no shipwreck-size bottom feature of potential cultural resource value exists in the project area. However, if any potentially significant historical, archaeological or paleontological feature is encountered during seafloor surveys, all anchoring must remain more than 100 meters from the feature. Therefore, the project would not impact any significant features and would be consistent with this section of the Coastal Act. See Section 4.5 for an analysis of potential project-related impacts to marine cultural resources.

5.7 Air Quality

Coastal Act Section 30253(3) states:

New development shall:

(3) Be consistent with the requirements imposed by an air pollution control district or the State Air Resources Control Board as to each particular development.

The project would not include any equipment that is regulated by the San Diego County Air Pollution Control District (APCD). The project would utilize an 80 to 100-foot work boat. A small vessel would also be utilized to shuttle workers to the project site on a daily basis. However, emissions associated with these sources would be below emission significant threshold levels and historic emission levels. Therefore, the project would be consistent with this section of the Coastal Act.

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Appendix I
Quality Assurance Programs and Related Experience

Because of its collective experience, RCF is well aware of the primary concerns related to aquaculture development. Recognizing that successful aquaculture programs require a multidisciplinary approach, RCF has developed supporting collaborations for research and operations in areas related to hatchery and cage production, fish nutrition, fish health, fish physiology, fish reproduction, fish tagging and tracking, genetics, site selection and permitting, environmental monitoring, and systems engineering. In addition, the RCF partnership will utilize an extensive, ever-growing network of outside collaborators to fulfill its problem solving needs.

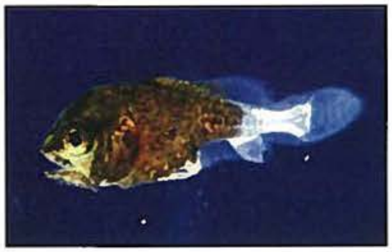


Figure I-1. White seabass larvae.

Hatchery Production

HSWRI is a national leader in the hatchery production of marine finfish and operates a production-scale hatchery in Carlsbad, California capable of rearing millions of fingerling white seabass per year. This is a cooperative program with the California Department of Fish and Wildlife (CDFW), with all seabass produced being released into the ocean to replenish wild stocks. Each fish has to meet the highest standards of quality in terms of appearance, health and genetic diversity. HSWRI also operates a research-scale hatchery in San Diego for rearing other commercially valuable species – both for replenishment and marine farming. Both these hatchery facilities use state-of-the-art, energy efficient life support systems and have been built and are operated to comply with California's rigorous permit requirements.

Figure I-2. Recirculating flatfish larval and juvenile system.

Offshore Cage Production

CdM is the global leader of new and innovative sea cage technology, operating in Panama and Mexico as far as 13 km (8 miles) offshore. CdM has the most experience in the operation and deployment of submersible cage systems in the world.

Fish Nutrition

Because several of the species being proposed for culture are new for the industry, formulated feeds have not been customized for them. HSWRI has developed its own nutrition program and is also working with nutritionists from the US, Mexico and Japan to develop the needed custom diets, including those with a reduced proportion of fish meal as a raw ingredient.

Figure I-3. Collecting biological samples as part of initial fish diagnostics.

Fish Health

Scientific understanding of marine pathogens is very limited. While some organisms are relatively easy to identify (e.g. parasites), others (e.g. viruses) are not. RCF scientists have teamed up with a network of local and international fish health professionals to gain access to their expertise and the most sophisticated detection and identification tools available. Additional information on RCF's Fish Health Management Program is found in Appendix III.

Figure I-4. Larval physiology experimental system.

Fish Physiology

In order to enhance culture success, it is critical to understand and refine the optimal rearing conditions that promote good growth and health in the fish under culture. These conditions are best measured by extensive laboratory trials testing physiological thresholds to variables such as water temperature. HSWRI has established an in-house physiology program and a broadening network of external collaborators.

Fish Reproduction

HSWRI maintains viable fish breeding populations of several regionally important species, including white seabass, yellowtail jack, and California halibut. Conditions within each breeding population are carefully controlled to provide the optimum environment for each species.

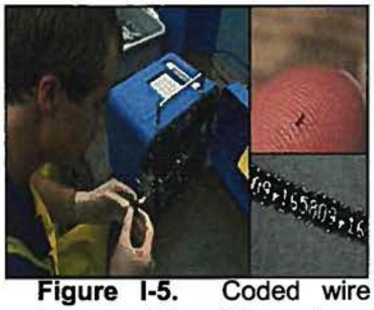


Figure I-5. Coded wire tags used for white seabass replenishment.

Fish Marking, Tagging, and Tracking

HSWRI has evaluated a variety of fish tags and tagging techniques, including external, visible implantable, coded wire, and acoustic tags. As part of their ongoing white seabass replenishment program, each fish is tagged in the cheek muscle with a coded wire tag, which is unique to each lot of fish released. HSWRI maintains a post-release assessment program that incorporates sampling of sub-legal sized fish, cooperation between recreational and commercial fishermen, and the use of acoustic tags and tracking techniques to gain a better understanding of released fish and their contribution to the wild population.

Figure I-6. White seabass broodstock.

Genetics

Stock replenishment programs require a substantive understanding of the genetic diversity of the population being supplemented, as well as that of the cultured fish being stocked. Breeding programs for traditional farming will look toward genetic selection to retain and improve positive attributes for culture such as disease resistance and growth enhancement. HSWRI is developing its genetic research program in cooperation with NOAA Fisheries.

Site Selection and Permitting

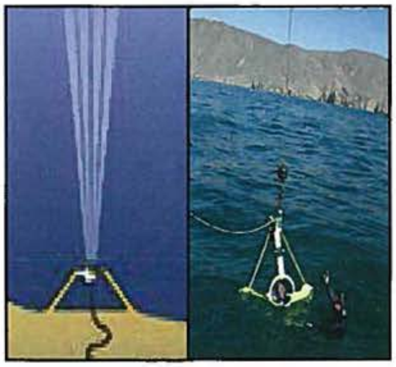


Figure I-7. Acoustic Doppler Current Profiler (ADCP).

Through its extensive experience in operating land-based and coastal facilities, RCF has developed an important core competency in acquiring the permits necessary to conduct aquaculture in the coastal zone, as well as in federal waters. RCF also has the tools and expertise to identify appropriate offshore sites for aquaculture. These include, but are not limited to an Acoustic Doppler Current Profiler (ADCP), which measures ocean currents at intervals from the surface to the sea floor. Data collected from water column currents, sediment and water quality analysis, as well as site and species information are then integrated into modeling programs that simulate water and sediment quality effects of fish farming operations in nearshore and exposed environments.

Environmental Monitoring

Figure I-8. Environmental sampling at a net pen operation.

RCF has established an extensive environmental monitoring program for its coastal cages in California, Mexico, and Panama. These programs have been developed in consultation with experts from around the country and patterned after the methods used in Washington State and British Columbia to monitor salmon farming operations toward developing best management practices to minimize impacts to the environment. The monitoring program in California has been approved by various coastal agencies in California. HSWRI also monitors effluent from its land-based facilities as a requirement of the Regional Water Quality Control Board.

Systems Engineering

RCF has developed an in-house capability for designing efficient and functional flow-through and recirculating life support systems for fish. These systems are critical for maintaining brood fish and rearing large numbers of sensitive larval and juvenile stages of marine finfish that can ultimately be stocked into cages.

Appendix II
Site Map and Mooring Configuration for RCF-SAP

Figure II-1. Project location: site detail with cage grid overlay

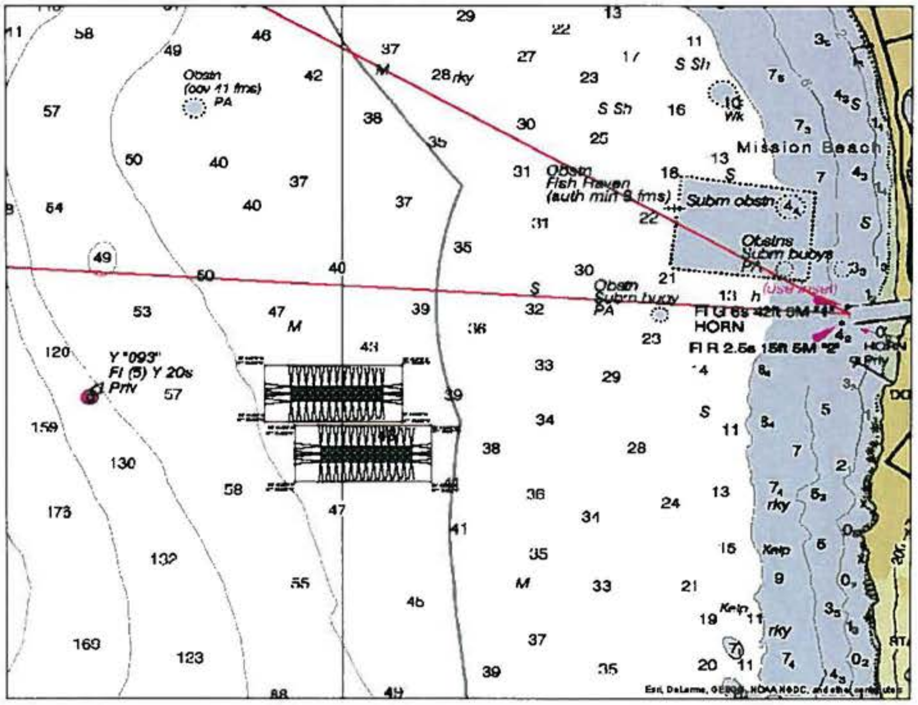


Figure II-2. Close up of cage grid overlay

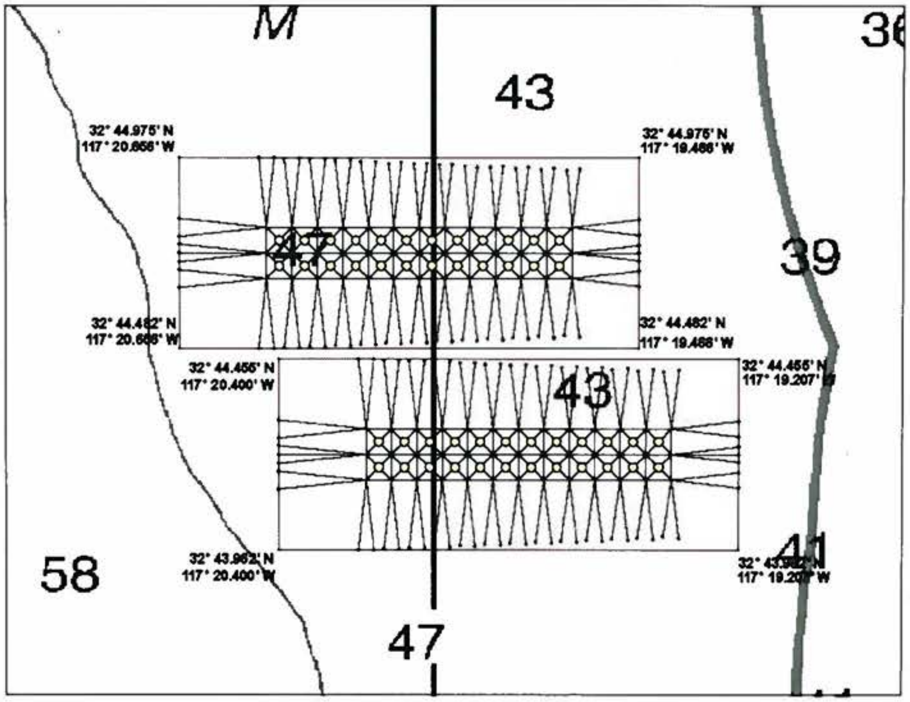
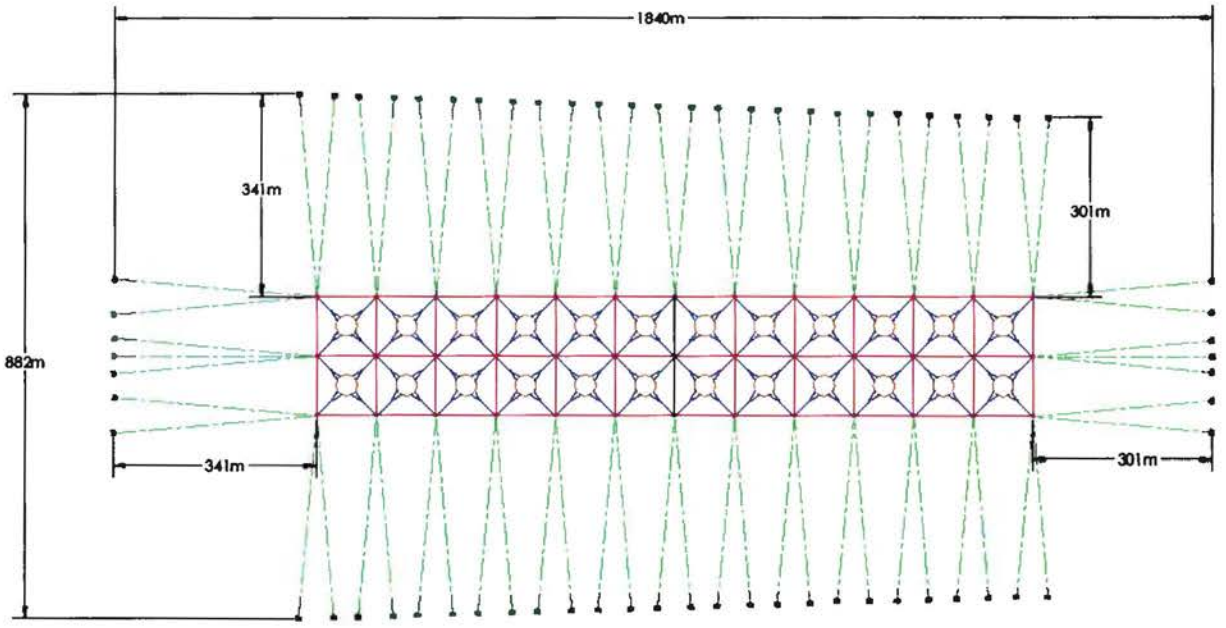


Figure II-3. Detail view drawing of cage grid and mooring system components



ANCHOR LINE SIZING AND REQUIRED FOOTPRINT

ASSUMES LINEAR CHANGE IN DEPTH FROM EAST TO WEST (77 TO 88 M DEEP)
ANCHOR LINES ARE 4:1 SCOPE

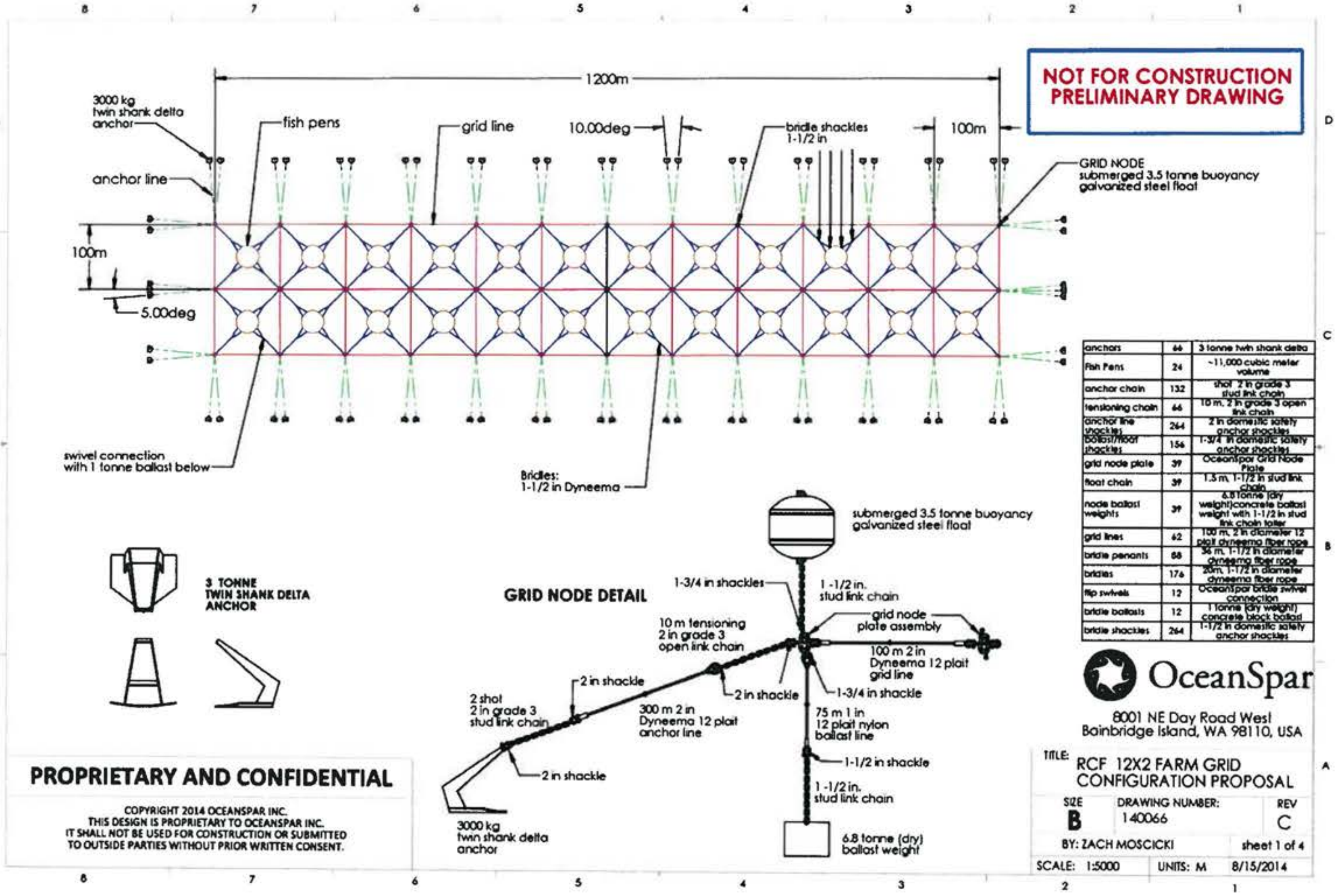
PROPRIETARY AND CONFIDENTIAL

NOT FOR CONSTRUCTION
PRELIMINARY DRAWING

OceanSpar
8001 NE Day Road West
Bainbridge Island, WA 98110, USA

TITLE: RCF 12X2 FARM GRID
CONFIGURATION PROPOSAL
SIZE B
DRAWING NUMBER: 140066
REV C
BY: ZACH MOSCICKI
sheet 2 of 4
SCALE: 1:6000
UNITS: M
8/15/2014

Figure II-4. Plan and elevation view drawings of cage grid and mooring system components



anchors	66	3 tonne twin shank delta
Fish Pens	24	~11,000 cubic meter volume
anchor chain	132	shot 2 in grade 3 stud link chain
tensioning chain	66	10 m, 2 in grade 3 open link chain
anchor line shackles	264	2 in domestic safety anchor shackles
ballast/float shackles	156	1-3/4 in domestic safety anchor shackles
grid node plate	39	OceanSpar Grid Node Plate
float chain	39	1.5 m, 1-1/2 in stud link chain
node ballast weights	39	6.8 tonne (dry weight)concrete ballast weight with 1-1/2 in stud link chain tailer
grid lines	62	100 m, 2 in diameter 12 plait dyneema fiber rope
bridle penants	88	36 m, 1-1/2 in diameter dyneema fiber rope
bridles	176	20m, 1-1/2 in diameter dyneema fiber rope
flip swivels	12	OceanSpar bridle swivel connection
bridle ballasts	12	1 tonne (dry weight) concrete block ballast
bridle shackles	264	1-1/2 in domestic safety anchor shackles

OceanSpar
8001 NE Day Road West
Bainbridge Island, WA 98110, USA

TITLE: RCF 12X2 FARM GRID CONFIGURATION PROPOSAL
SIZE: B
DRAWING NUMBER: 140066
REV: C
BY: ZACH MOSCICKI
sheet 1 of 4
SCALE: 1:5000
UNITS: M
8/15/2014

PROPRIETARY AND CONFIDENTIAL

Appendix III
Fish Health Management

Disease Prevention

RCF's approach to aquaculture health management begins with disease prevention. Disease prevention is only possible when the culture requirements of the animal are well understood and accommodated to every extent possible, or when best management practices are employed for new species. Examples of culture requirements and best management practices are discussed below. It is important to recognize that factors affecting fish health status are complex. Fish health status cannot be determined solely by the presence or absence of infectious agents (i.e. pathogens). More often than not, infectious diseases that lead to death of the host are opportunistic and secondary to some other stressor (e.g. poor water quality, nutrition, husbandry, immunity) that is the primary cause of mortality. The application of antibiotics and chemicals to control disease is governed by the U.S. Food and Drug Administration's (FDA's) Center for Veterinary Medicine (CVM), and is limited to 1) approved drugs, 2) special category and low regulatory priority compounds, 3) veterinarian prescription by "extra label use", and 4) Investigational New Animal Drug (INAD) research programs.

Stock Origin and Biosecurity

All fish species proposed to be grown are native to or established in California. Biosecurity refers to measures taken to ensure that the fish in culture are secure from infectious agents. Potential vectors for disease are identified and mitigated to every extent possible. When new fish are brought into the hatchery or cages, they are inspected by a certified health professional, quarantined, and treated for any diseases as necessary. Water is sterilized using ultraviolet light, and ozone in recirculating systems, and the volume of new water added is relatively small. Employing these procedures minimizes the risk of introducing diseases from other culture facilities or wild fish. Similar safeguards are employed with regard to feeds, where only fresh, high quality fish food is used. Good hygiene practices are employed with regard to culture systems, equipment and personnel. All nets, siphon hoses, feed containers, and any other equipment used for operations are cleaned and disinfected after use. Each rearing system has its own footbath for personnel moving between systems for cleaning and feeding. Mortalities are removed and disposed of immediately, so they do not provide an additional vector for disease.

Environmental Conditions

Environmental requirements vary among species, but can often be inferred based on the lifestyle of the species in the wild. Water quality is extremely important for aquatic organisms; therefore, the quality of the water is maintained at high standards to avoid stress and disease. Many common diseases occur because of poor water quality. Good water quality is characterized by high dissolved oxygen, and low levels of waste (ammonia, nitrite, and suspended solids). These parameters are measured daily and compensated for by properly designed systems and sound husbandry practices. Adequate water flow, particulate and biological filtration, supplemental aeration, good feeding practices, and routine cleaning are the key elements to maintaining excellent water quality. Water temperature is also very important. Species selected for culture must be tolerant of the full range of temperatures experienced at an offshore farm site, or the temperature must be controlled when possible such as at the hatchery facility. Other environmental variables such as lighting (quality, intensity, and photoperiod), current velocity, and vibration must be optimized in order to reduce stress.

General Husbandry

Good husbandry practices are a key element to health management. Husbandry is a general term that refers to how the animals are cared for and therefore encompasses many of the topics being discussed. Fish densities are maintained at a level that is compatible with a given species' tolerance for crowding and the engineered capacity of the system. Physical or visual exposure to potential predators can be a major source of stress to cultured fish. This exposure is avoided by employing predator nets outside cage systems, and grading fish to reduce cannibalism in tank systems. Whenever fish are handled (e.g. for grading), techniques are used that minimize stress and physical trauma to the fish's protective mucous layer. Examples of these techniques include keeping the fish suspended in water whenever possible, using knotless mesh nets, wearing gloves in case of contact, and commercially available mucous-restoring compounds. Culture systems are sterilized between crops. Cage nets are cleaned and cages may be left to fallow for several weeks prior to restocking.

Feeding and Nutrition

Good nutrition is the foundation for a healthy fish and fast growth. Fish are fed only fresh, high quality feeds. Hand feeding allows daily assessment of the activity level, health status, and satiation level of the fish. Multiple feedings throughout the day are facilitated by automatic feed delivery systems. Feeding schedules are adjusted to match the activity patterns of the fish.

Prophylactic Measures

At the present time little is done in the way of medical prophylaxis; therefore strict biosecurity protocols are followed as prophylactic measures against pathogen introduction. This is due largely to the fact that the marine finfish culture industry is new and species-specific prophylactic treatments (e.g. vaccines) have not been developed. For example, newly spawned eggs are immersed in a dilute formalin bath as a prophylactic treatment. The formalin rids the egg surface of bacteria and fungi and helps prevent potential pathogens being transferred to the larvae at hatching.

Appendix IV
Risks and Risk Management

Risks and Risk Management

Extreme Weather

Working offshore in potentially hostile ocean conditions represents a possible risk to any ocean farm. Damage from storms can lead to equipment damage, physical injury and loss of stock. These risks can be mitigated if the appropriate equipment, engineering and experience are matched to the site-specific ocean conditions.

The project will use sea cages that have been proven effective in hostile, offshore environments. This includes withstanding hurricanes and typhoons, as well as routine currents of up to 4 knots and seas in excess of 8m. While the equipment is proven effective in these conditions, actual observed conditions at the proposed site fall well below these criteria. Project personnel have direct experience working with these types of systems in harsh environments. The equipment is off-the-shelf technology, and available for all phases of production. Critical to the success of these systems are their associated mooring and anchoring configurations. Project personnel, equipment manufacturers and licensed marine contractors are working together to ensure that the appropriate mooring system is selected and installed properly according to site-specific characteristics. All installations will be inspected on a regular basis and after storm events.

Pollution

Pollution in the form of land-based discharges, storm water run-off, and harmful algal blooms (HABs) represents a potential risk to livestock in ocean farms. These risks can be mitigated in a variety of ways that include 1) siting the farm outside the range of discharge plumes and HABs, 2) working with species that are more tolerant to HABs, 3) using submerged cages to keep the fish below the affected surface layer, and 4) having a quick response plan that allows cages to be moved outside the polluted zone.

The project plan is to site the cages to avoid pollution events in pristine waters that are outside the coastal zone. The coastline of southern California is well studied, so that the characteristics of pollution plumes are well documented and have been modeled relative to seasonal currents and storm effects.

Predation

Fish losses or system damage from predators and vandals is a potential risk to ocean farms. Potential predators include sharks, marine mammals, birds and people. The risk of predation can be mitigated by 1) removing mortalities routinely from the cages, 2) using anti-predator devices, and 3) having a comprehensive and responsive security program. The project will use a combination of each of these measures as detailed below.

1) Sharks can be avoided by proper management and implementation of sound mitigation measures. At all of RCF's cage systems, best management practices will be

implemented into all daily routines to ensure that predator interactions are minimized and optimal husbandry requirements are met.

2) Three types of fish cages will potentially be used for the project: Traditional gravity cages, traditional and Double Rim (DR) SeaStation fish cages, and Aquapod cages.

Traditional gravity cages and DR SeaStation cages are designed for large-scale submerged or surface operations in medium-to-high energy open ocean sites (Figure 8). SeaStation's patented, central spar design provides excellent sea-keeping abilities in open ocean conditions and through major storm events. These cages are constructed with a galvanized steel framework, surrounded with an option of different netting materials, depending on the operator's preference. These cages are currently being operated at commercial production levels in several locations throughout the world. RCF proposes using 11,000 m^3 cages and increasing the number of cages being used incrementally to a maximum of 24 cages per mooring grid.

The Aquapod submersible fish cage is also uniquely suited for rough, open ocean conditions. The Aquapod is constructed of individual triangle net panels fastened together in a spheroid shape. Most Aquapod net panels are made of reinforced high density polyethylene with 80% recycled content and covered with coated galvanized steel wire mesh netting. Individual net panels or groups of panels are modified to accommodate other functions, such as access, feeding, fish transfer, grading, and harvesting. The Aquapod functions as a secure containment system for finfish while submerged or partially surfaced.

3) For both traditional gravity cages and DR SeaStation cages, Kikko Net mesh material can be used. Kikko Net is a Tetron plastic wire that can be molded into a variety of mesh sizes. The strong material acts as its own predator exclusion mesh. The nets are environmentally friendly as no harmful materials are included in the raw material, and they are nonconductive to electricity. Additionally, because Kikko Net is non-fibrous, fouling does not grow into the material itself, making it easier to clean than standard woven fish netting.

The California sea lion is commonly found in colonies along the southern California coast and is known to haul out on navigation buoys and other types of floating surfaces. If traditional gravity cages are used, anti-predator nets will help deter sea lions from the sea cages beneath the surface. The design of the DR Seastation cage already incorporates a taut cone-shaped net when the cage operates at the surface that acts both as a sea lion and bird deterrent. In the case of traditional gravity cages, a simple net "fence", with a mesh size of 8 cm stretch and 2 m height will be installed around the cage collar at the surface so that sea lions will not be allowed onto the cage structure and to prevent them from being able to jump inside. This method is simple and has been proven effective on marine cage farms located in Mexico and in British Columbia.

To avoid predation by birds, net material is typically stretched over the top of the cage and attached to the handrails of the cage collar. As stated previously, the taut cone-shaped net of the SeaStation cages acts as an anti-predation net when the system operates at the surface and does not require a secondary anti-predation net. For the traditional gravity cages, cover nets, or bird nets installed on cages as part of this project will be 2.5 to 5 cm square mesh and be stretched taut over the cage surface, be of high visibility cover, as well as be marked with reflectors to reveal the presence of the nets as an additional measure to prevent entanglements.

4) The project will have security staff present 24 hours a day on a moored vessel. Constant security will minimize the risk of any vandalism or theft.

Appendix V
Yellowtail Jack (*Seriola lalandi*)

Fishery Information

A transitory, seasonally abundant species in southern California, yellowtail jack are valued as both a game and food fish. Sport and commercial fisheries for yellowtail jack have existed off the coast of California since the end of the 1800s. Commercial landings of yellowtail during that time have ranged from 11.5 million pounds (1918) to just under 1,000 pounds (1995), and landings have typically fluctuated with both water temperature and commercial demand. The current range of the fishery is restricted to the waters south of Point Conception.

Originally caught using handlines, commercial fishing for yellowtail jack transitioned to hook-and-line fishing in 1898. Until 1933 the commercial fishery was restricted to live bait boats off southern California and Baja California, Mexico. After 1933, however, purse seiners were restricted to fishing south of the Mexican-American border in response to declining catches in California waters. However, gillnet boats reported incidental landings of yellowtail while fishing for white seabass. This continued until 1994 when nearshore gillnetting was banned, leaving only hook-and-line fishing and farshore (greater than three miles) gillnet fishing. Beginning in the 1950s, private boaters also began taking a significant number of fish, sometimes landing more than the catch reported by commercial passenger fishing vessels.

Maturity and Reproduction

Yellowtail jack are fast growing, gaining about three to four pounds per year. The largest recorded weight is 80 pounds; however typical weights for landings in southern California and the Coronado Islands are 4-12 pounds, and 12-18 pounds in Baja California. Using gillnets, commercial catches range from 10-20 pounds, while 4-12 pounds is typical for hook-and-line fishermen. Both males and females move offshore to form spawning aggregations during the spawning season, which runs from June through September. All females over three years old are capable of spawning and sometimes spawning occurs at two years old. A 20-pound fish is capable of producing over 900,000 eggs in one spawning season.

Aquaculture

Currently, the majority of *S. lalandi* is cultured off of S. Australia; however, attempts have also been made to culture *S. lalandi* in New Zealand and Chile, both in seacages and using land-based farming methods. Most cultured *S. lalandi* is sold to the Japanese restaurant market for consumption as sashimi, and is marketed as 'hiramasa'.

All cultured yellowtail used in sushi markets, including the U.S., is currently farmed. RCF's proposed production will represent 3% of global production when the farm is fully built out, and will not compete with the local wild fishery, only with foreign imports.

Captive broodstock are held at HSWRI's research facility in Mission Bay, San Diego under ambient conditions and provide eggs in the spring and summer. HSWRI has conducted growout and marketing trials on this species. Preferred market size is 3-4 kg (6-9 pounds). However, their production cycle can range from 24-36 months, depending on water temperature. In cooler waters, such as those in the project area, the cycle is typically extended.